

PAPUA NEW GUINEA
MOROBE PROVINCIAL ADMINISTRATION
LAE URBAN LOCAL LEVEL GOVERNMENT

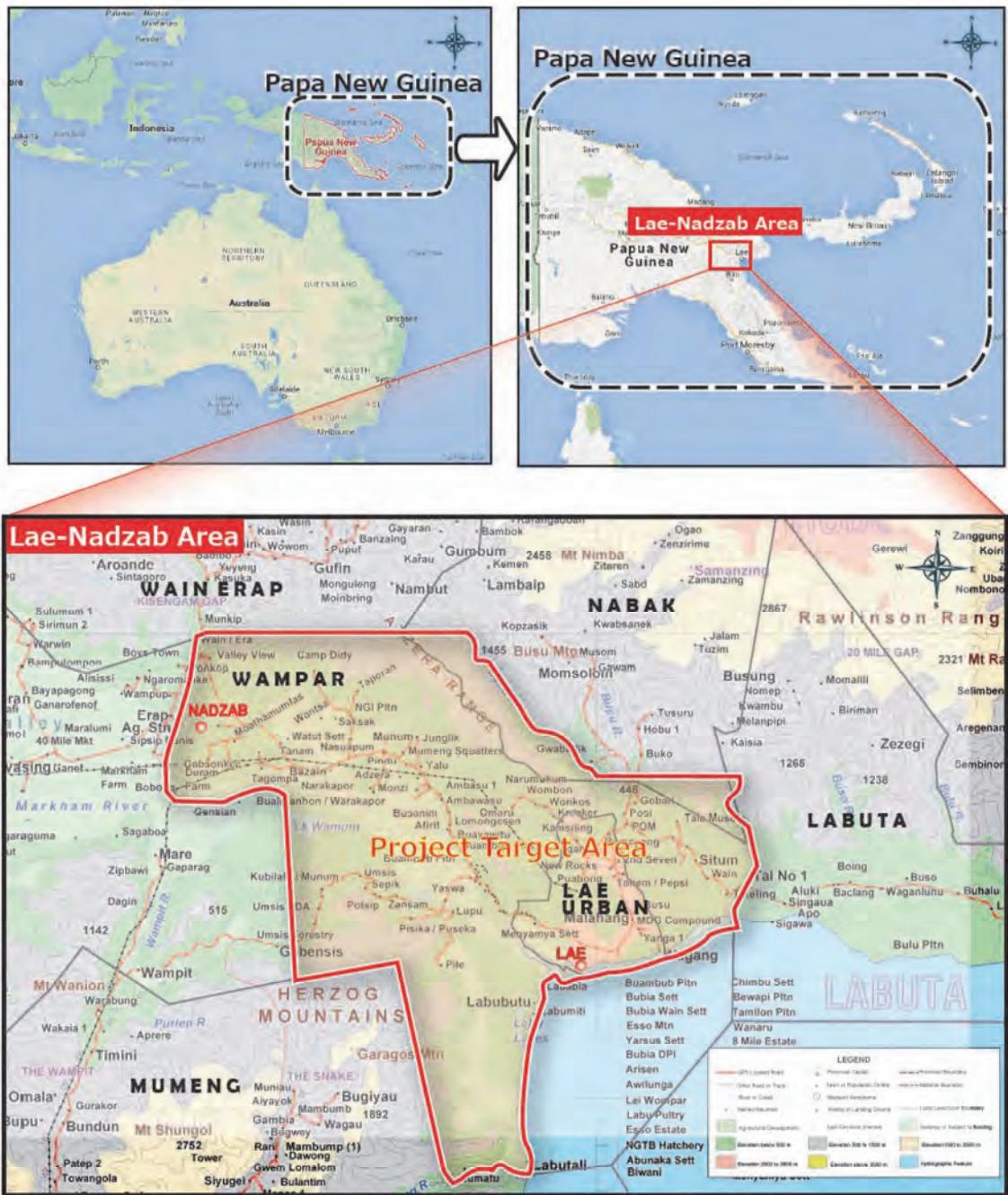
**THE PROJECT FOR THE STUDY
ON LAE-NADZAB URBAN DEVELOPMENT PLAN
IN PAPUA NEW GUINEA**

**FINAL REPORT
(SUMMARY)**

FEBRUARY 2017

**JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
YACHIYO ENGINEERING CO., LTD.
KOKUSAI KOGYO CO., LTD.**

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JR
17-058



LOCATION OF THE PROJECT AREA

Exchange Rate: PGK 1 = JPY 34.48
(Average of April 2016 – June 2016)

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LIST OF ABBREVIATIONS

Notes	Description
ADB	Asian Development Bank
AAGR	Annual Average Growth Rate
ARAP	Abbreviated Resettlement Action Plan
C&I	Commercial & Industrial Areas
CEPA	Conservation Environment Protection Authority
CHP	Community Health Post
DLPP	Department Lands and Physical Planning
DOH	Department of Health
DOT	Department of Transport
DOW	Department of Works
DPLGA	Department of Provincial and Local Government Affairs
EIA	Environmental Impact Assessment
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GOJ	Government of Japan
GOPNG	Government of Papua New Guinea
GRDP	Gross Regional Domestic Product
ICDC	Industrial Centre Development Corporation
ILG	Incorporated Land Group
IPA	Investment Promotion Authority
JICA	Japan International Cooperation Agency
LLG	Local Level Government
LNG	Liquid Natural Gas
LNUDP	Lae Nadzab Urban Development Plan
LULLG	Lae Urban Local Level Government
MPA	Morobe Provincial Administration
MPG	Morobe Provincial Government
MPIDP	Morobe Provincial Integrated Development Plan 2014-2018
NDC	National Disaster Committee
NEC	National Executive Council
NGO	Non-Governmental Organization
NRI	National Research Institute
O&M	Operation and Maintenance
OD	Origin-Destination
PCU	Passenger Car Unit
PMV	Public Motor Vehicle
PMU	Project Management Unit
PNG	Papua New Guinea
PNGDSP	Papua New Guinea Development Strategic Plan 2010-2030
SAR	Search and Rescue Operations
SME	Small and Medium Enterprise

*The Project for the Study on Lae-Nadzab Urban Development Plan
in Papua New Guinea*

Notes	Description
SOP	Standard Operation Procedure
SOPAC	South Pacific Applied Geoscience Commission
STP	Sewage Treatment Plant
TOR	Terms of Reference
UNITEC	University of Technology, Papua New Guinea
WB	World Bank
WTP	Water Treatment Plant

PART I

BACKGROUND CONTEXT

INTRODUCTION OF THE PROJECT

Background of the Project

The city of Lae is the capital of Morobe Province, and Papua New Guinea's second largest city after the national capital of the country, Port Moresby, with a current population about 200,000. Lae Port is located at the central area of the city and it has the largest container handling capacity in the country. It is currently under development by ADB's assistance to expand the service capacity as a part of a plan to make the region industrial, manufacturing and distribution center. Nadzab Airport, on the other hand, is serving as a domestic hub airport for the northern PNG region, and it will be expanded by Japanese ODA loan. The Highlands Region, neighboring the study area of the Project (Project Area), is one of the largest agricultural production centers with high potential of natural resources for development.

"Lae-Nadzab Urban Development Plan (LNUDP) 2005-2015" was prepared and approved to develop Lae-Nadzab area. However, major developments planned in LNUPD have not been implemented so far due to lack of proper coordination between publicly financed infrastructure development and the urban development.

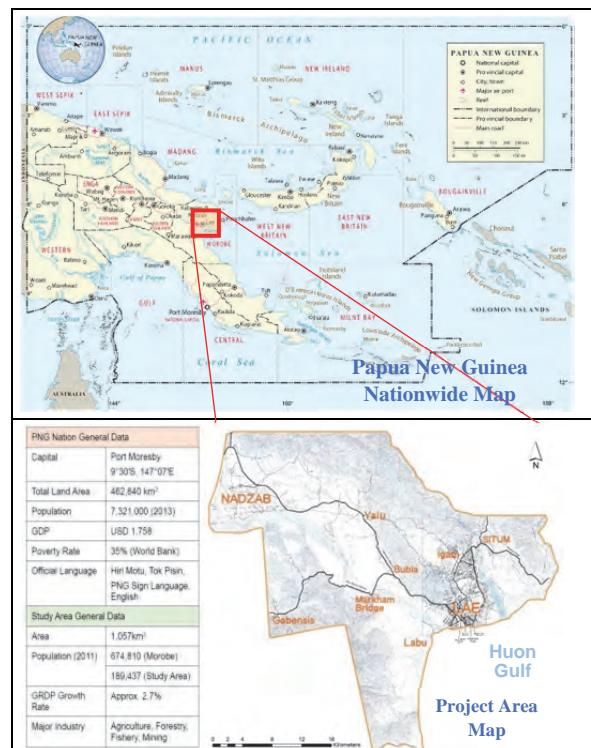
The Government of PNG (GoPNG) has acknowledged the issue, and in August, 2012 GoPNG requested the Government of Japan (GoJ) for assistance to formulate a master plan which set a more realistic urban development plan for the region. Accordingly, as the Record of Discussion (R/D) signed by GoJ and GoPNG describes, the "Project for the Study on Lae-Nadzab Urban Development Plan" has been initiated.

Purpose of the Project Study

The main objective of the Project is to prepare an effective and realistic urban master plan for Lae-Nadzab area. In order to envision the best solution for the master plan, the Project has reviewed all related development plans of the Province and the country as well as analyzed current situation of the region to identify the development problems and issues. Land ownership also is a major concern for better solutions to achieve better and more beneficial regional development, as this has been historically a hindrance to make proper

development in the country.

The study conducted several surveys including traffic count, origin-destination and household interview surveys and also analyzed the current development problems and social infrastructure demand in order to formulate LNUDP (2016-2025) with the most possible economic and industrial development, utilizing local resources and benefitting all populations of the area. The target year of the master plan is set as 2025 with ten-year planning period. After the preparation of the master plan, the study has identified priority projects, and conducted a pre-feasibility study for a selected priority project.



Source: Prepared by JICA Project Team using Map of Papua New Guinea from Geographic Guide (Nation Map)

Project Area Map

CHAPTER 1 THE NATIONAL, REGIONAL AND PROVINCIAL CONTEXT

1.1 Location and Status of Lae-Nadzab Area

The area covered by this plan – the Lae-Nadzab Urban Development Plan (LNUDP) not only includes Lae City but also its surroundings, extending along the Highlands Highway to Nadzab Airport in the west, and to the Bunga River and Situm in the east. The area also extends to Labu area in the south and to the Huon Gulf and the mountain ranges in the north, forming the natural boundaries.

The acreage of the entire Lae-Nadzab area covered by this plan is 1,057 km² and composed of five local level governments, namely, Lae Urban (ULLG), Ahi Rural, Wampar Rural, Nabak Rural and Labuta Rural. The area also covers Lae, parts of Huon Gulf and Nawaeb Districts in Morobe Province. Lae City administrated by ULLG is the capital of Morobe Province. The population of the Lae-Nadzab urban development area in 2011 was some 190,000, according to the National Population Census (NSO). Lae is the second largest city of PNG next to Port Moresby, and the Lae-Nadzab area population has been growing with development of the economy.

Lae Port, the largest port in PNG functions as import and export port and a hub port of the domestic sea transport network in the island country. Nadzab Airport is an inland airport located 35 km northeast of Lae City. The Airport is expected to be a gateway of not only PNG but also of South Pacific countries under the current Nadzab Airport Improvement Project.

Moreover, Lae is located at an intersection of corridor roads. Out of such corridor roads, Highlands Highway is the backbone of the Lae-Nadzab area connecting Lae with Nadzab Airport and further with Highland area in the northwest.

As regional transport network is being established by improvement projects of Lae Port (Lae Tidal Basin Development Project), Nadzab Airport (Nadzab International Airport Development Project) and Highlands Highway (Highlands Highway Improvement Project), a

substantial improvement of regional transport potential is expected.

With such advantageous regional transport network, Lae-Nadzab Area has large economic hinterlands of Morobe, Eastern Highlands, Madang, Chimbu, Western Highlands, Enga, Southern Highlands, Hela and Jiwaka. Especially Highlands, which exports coffee, cocoa, tea and other agricultural products and imports food, construction materials and machines, industrial goods and heavy equipment, depends directly on Lae in terms of logistics.

Under such regional transport potential and large area of hinterlands, logistic companies, fish processing factories and processing factories of agricultural products by both foreign and domestic investors are located in Lae. As Lae-Nadzab area is functioning as a base for logistics and industry, further development is expected in this area.

Furthermore, as PNG Forestry Research Institute, PNG University of Technology (Unitech), National Cancer Institute, Lae School of Nursing, and non-governmental organizations are located in Lae-Nadzab area, this area bears the role of educational and cultural centre of PNG.

1.2 Role of Lae-Nadzab Urban Development Plan

According to major national level plans and policies, such as Papua New Guinea Vision 2050 and Papua New Guinea Development Strategic Plan 2010-2030, Morobe Province, especially Lae-Nadzab area is highly emphasized as the industrial and distribution centre of the country. Instead of depending on business activities of Port Moresby (POM), shifting the actual centre of the economic activity to Lae-Nadzab area while retaining POM as political centre is being considered. Because of its geographic location in the country, Lae port has already become the largest distributing port of PNG. Lae-Nadzab area has large potential within the Pacific island countries, Oceanian Region, Indonesia as well as Southeast Asian countries for more trading activities in the future. It will also benefit from its geographic position in the domestic economic activities from island region, highland region and others.

With its access to the oversea resources and products, but also local resources, such as agro-products, timbers, and mining and fishery resources, Lae Nadzab area should benefit the future industrial and manufacturing development not only domestically but also internationally in the long-term vision. The Government of PNG (GoPNG) has aimed at overcoming economic issues concerning import-oriented market structure and weak production as well as at solving issues of land use and customary land registration processes in the area. Instead of dealing with developed POM region for finding the solution, Lae-Nadzab area should provide more flexible development options with newly set-up urban development guidelines and regulations in order to realise a new economic centre of the country with more sophisticated industrial and distribution system and infrastructure.

ADB's assistance for Lae Tidal Basin Development Project and JICA's assistance for Nadzab International Airport Development Project as well as other donors' development assistance are either on-going or up-coming to the region to speed up the regional development for better economic activities. Thus, setting up a new urban master plan focusing on Lae-Nadzab area development with appropriate regulation and guideline application for proper land use is a timely project for fulfilling the demands, and this master plan and its implementation should be able to showcase the new and effective development model.

With the current improvement in the state of the economy boosted by the mining industry, Lae is going through a period of increased urban growth with rapid population concentration, thus causing large demand for residential land with the consequential effect on the provision of urban/city public services.

The existing Lae-Nadzab Urban Development Plan was prepared and approved for implementation in 2005 with a time frame of ten years. It is assessed, however, that the implementation of the plan was not fully executed. With the current rise of the economy of the country and the region, spontaneous developments are spreading rapidly with great possibility of future expansion of the city and its urban functions into the outer lying areas of the city.

Under such circumstances, GoPNG decided to review and update the urban development plan for Lae-Nadzab area with an approbation of Morobe Provincial Administration (MPA), Lae Urban Local Level Government (ULLG) and other authorities concerned. This report sets forth the expected goals and methodology of the Project.

The purpose of the Project is as follows:

(1) Project purpose

- To promote long-term sustainable economic and social development in Lae-Nadzab area through formulation of urban development plan and implementation of pre-feasibility study

(2) Outputs of the Project

- Urban development plan (2016–2025) for Lae-Nadzab area
- Pre-feasibility study for a prioritized project

Figure 1.2.1 below illustrates the Project study implementation schedule.

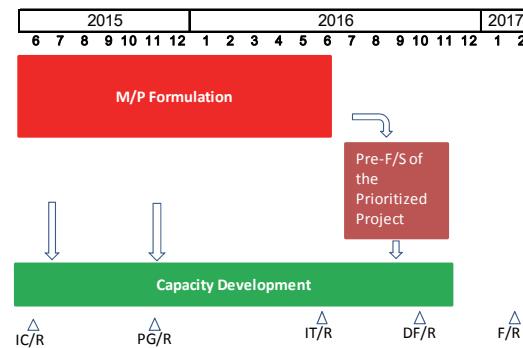


Figure 1.2.1 Project Study Implementation Schedule

CHAPTER 2 PHYSICAL AND CLIMATE CHARACTERISTICS

This Chapter outlines the present conditions of the environment of the Project Area. The purpose is to describe the baseline conditions in order to assess potential for natural hazards to enable better understanding of the risks in the development planning.

2.1 General Background

2.1.1 Morobe Province

Morobe Province shares common boarders with West New Britain to the east, Madang Province to the north, Eastern Highlands to the west, Gulf Province to the southwest, Central to the south, and the Oro Province to the southeast. It has a total land and maritime area of 34,650 km².



Source: Map of PNG from Geographic Guide (Nation Map)

Figure 2.1.1 Map of PNG and Morobe Province

The topography ranges from the sea level to over 4,000 m a.s.l. and can be broadly divided into two major divisions, the highlands and the lowlands.

Land use potential for agricultural development lies around the coast to the south, including the Markham Valley floor and the entire coastline of the Huon Peninsular.

2.1.2 Project Location and Lae Setting

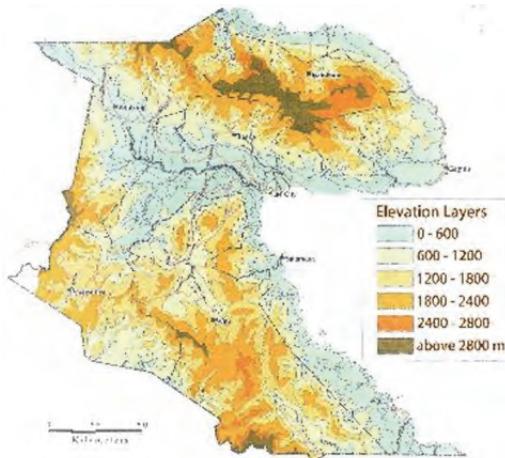
Lae City is situated at the eastern end of the Markham Valley. Three major rivers characterize the river system in the Project Area; Markham River in the west of Lae and the Bumbu and Busu rivers immediately on the east. These rivers have history of flooding causing considerable damage to the city.

The Project Area is an extension of the external boundary of the Lae Urban encompassing areas within three Districts (Nawaeb, Lae, Huon Gulf) comprising of a total of 1,057 km² with a population of around 200,000 people.

2.2 Physical Environment

2.2.1 Topographical Constraints

Any topographical issues of concerns arise from the ridges and foot hills of the Rawlinson Range extending from the Situm River to the Atzera Range and onto the Markham Valley where landslips are naturally occur due to unstable geology and forest clearance enhanced by rainfall.



Source: Morobe Provincial Administration

Figure 2.2.1 Land Elevation Map of Morobe Province

Potential problems are compounded by heavy flooding of the Markham, Bumbu and Busu Rivers.

2.2.2 Geology

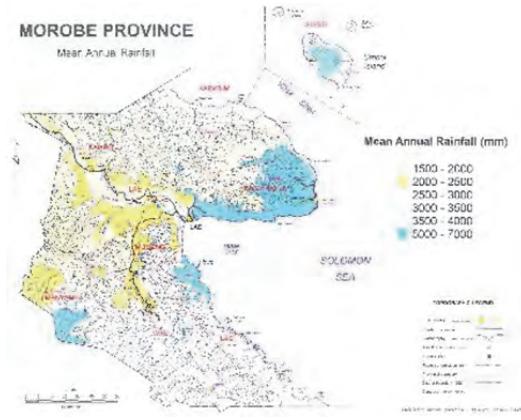
The Project Area is located on a geologically unstable zone where interacting crustal plates cause geological faults and movements that render the city and the region vulnerable to serious seismic activities. It is also located on the Pacific Ring of volcanos and geologic instability has produced numerous faults and earthquakes.

2.2.3 Soils

Dominant soil types of Morobe Province are Humitropepts, Dystropepts, Troporthents and Rendolls, and Inceptisols covering 54 % of the Morobe Province.

2.2.4 Climate

The climate is tropical equatorial characterized by wet and dry seasons. Lae City experiences a humid tropical climate, with an annual precipitation of 4,500 mm, and with an average annual temperature of 27 °C.



Source: Morobe Provincial Administration

Figure 2.2.2 Rainfall Map of Morobe Province

2.2.5 Rainfall

The interior and the coastal areas of the province between Finschafen and Morobe south coast have highest annual rainfall that amounts between 3,000 mm and 5,000 mm. The remaining part of the province receives annual amounts of between 2,500 mm and 3,000 mm.

2.2.6 Temperature

The temperatures of the province are as follows: 26 °C and above at coastal areas, 20–26 °C at inland areas, and from 0–20 °C at highland areas.

2.3 Biological Environment

2.3.1 Vegetation

Forest cover is the dominant vegetation in PNG characterized by diverse tree species reflecting the wide range of climatic, geographical and geological conditions. The natural vegetation within the vicinity of the Project Area varies considerably characterized by medium crowned lowland hill rainforest.

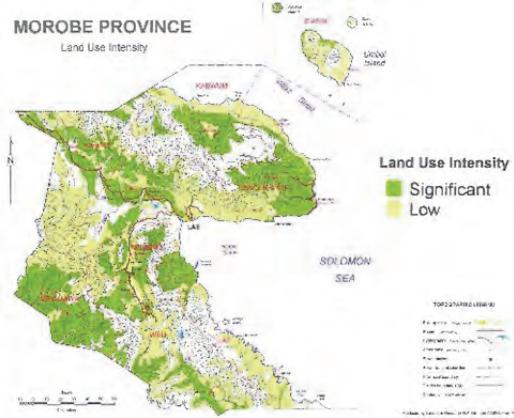
2.3.2 Aquatic

Over 57 % of the Morobe Province has potential for groundwater while nearly 43 % fall under the zone category showing inequality in the distribution of the groundwater potentiality in the Province. Water PNG Limited, a state owned enterprise (SOE) is responsible for the water resource use and supply in PNG except for the National Capital District, Port Moresby.

2.3.3 Coastal Environment

Morobe Province has a 719 km² of maritime area with a stretch of 402 km of coastline. The Markham, Bumbu, and Busu Rivers provide a diversity of aquatic, marsh and mangrove habitat areas that also provide abundant resources for

the coastal communities. Coral reef habitats within the immediate coastline of Lae do not exist due to discharge of sediment from the Markham River.



Source: Morobe Provincial Administration

Figure 2.3.1 Land Use Intensity of Morobe Province

2.4 Lae City and Climate Change

It is noted that initiatives have already been taken at the provincial government level in working together with the Office of Climate Change and the Natural Disaster Office to streamline development policies through integrating climate change and disaster strategies into the provincial development plans.

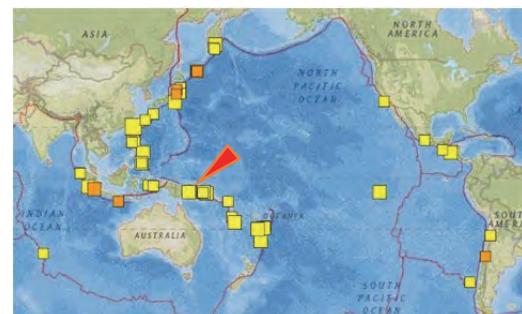
2.5 Natural Hazards

The following section provides a brief description of the natural hazards that could affect the project design and development.

2.5.1 Potential Hazards of Project Area

The Project Area is located in a geologically unstable area that warrants careful attention in undertaking future design and planning for city development. The existing geomorphology and topography of the Project Area is the result of many millions of years of geological instability.

The principal potential geologic hazards in the Project Area are earthquakes, river floods, landslides, landslide dam bursts, coastal erosion, tsunamis, and submarine slope instabilities.



Source: USGS

Figure 2.5.1 Occurrence of Earthquake in Pacific Region (Magnitude 4.5 or higher)

CHAPTER 3 ECONOMIC CHARACTERISTICS

3.1 Economic Overview

PNG is a lower middle income country in terms of GDP per capita in current basis as well as purchasing power basis. GDP was US\$1,758, in 2013, according to IMF. However, GINI coefficient is high in PNG.

According to IMF, employed population breakdown according to the industry is 72.3%, 3.6% and 22.70%, respectively. The GDP share and industry-wise employees' breakdown suggest manufacturing is biased towards capital incentive sector and does not provide enough job opportunities.

(1) Trade and Trade Balance

PNG's exports were conventionally dominated by gold and copper; however, from the second half of 2012, the country also started exporting nickel and cobalt. As for imports, PNG buys a wide range of finished products ranging from industrial articles to household consumables and processed foods.

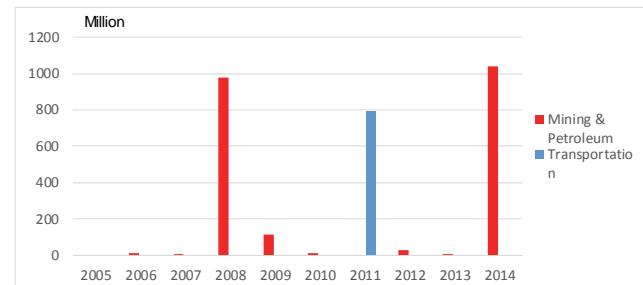
(2) Exports and Imports

The value of exports between 1995 and 2007 greatly exceeded the value of imports. From 2005 onwards, both exports and imports showed steady growth.

The trade scale had grown by threefold since 2005 in comparison with the previous two decades. In this regard, PNG seemed to have joined the globalization framework since beginning of 2000.

(3) Foreign Direct Investment (FDI) Flow

Foreign direct investment in PNG was approximately USD 2.9 billion in 2012, which was the highest level in the past five years. The top investment sectors over the five-year period of 2007–2012 were petroleum and gas (drilling), construction, agriculture, mining & quarrying, and real estate. In 2012, 87% of foreign capital was invested in the petroleum and mining & quarrying sectors. In terms of the investment sources, Australia was leading followed by Malaysia. Speaking of FDI inflow to Morobe Province in this decade, mining sector is outstanding among all sectors. Fishery subsector is the most outstanding in non-mining sectors.



Source: IPA

Figure 3.1.1 FDI Focusing on Morobe Province

3.2 Industry Sector

3.2.1 Industrial Structure

According to GDP shares by industry, two sectors, i) agriculture, forestry & fishing and ii) mining, quarrying & petroleum, account for 55% in 2011, indicating just how important they are to PNG.

As for the composition of employment, almost 90% of workers are engaged in agriculture and forestry for subsistence in the entire local level government (LLG) jurisdictions except that Lae Urban LLG (ULLLG). Urban industries such as manufacturing, construction, wholesale, retailing, transport, real estate are prominent in ULLLG area.

3.2.2 Overview of Business Climate identified through Interview Survey

Currently, a total of 34 companies are listed in Lae Chamber of Commerce in manufacturing sector, and over 90% are categorized as light industries and 79% are foreign shareholding companies.

3.3 Employment

Regarding population by age group of the Project Area in comparison with all of PNG and Morobe Province, the share of the economically active age group (15–64) is comparatively high. Similarly, the comparison of each LLG population by age group shows that the share of the economically active age group is comparatively higher in Lae Urban and two neighbouring LLG jurisdictions.

The Lae District Five-Year Development Plan 2013-2017 states that national entities employ only 15% of labour force. Moreover, according to the IPA survey, foreign capital enterprises employ 56 % of labour force, local companies 28%, and national companies 15%.

Also, a survey by Investment Promotion Authority in 1996 suggests that the total capital investment by foreign companies in Lae was PGK 445 million while national capital invested PGK 62.8 million.

As can be seen above, the national capital companies has not grown up yet in Lae City

Fishery in PNG and Tuna business

PNG has a high potential in terms of fish-culture, processing of tuna, lobster, shrimp and crab. Especially, tuna fishing is PNG's investor - attractive and export - valuable subsector because supply capacity of PNG fisheries zone accounts for about 10% of the world tuna market. PNG government has licensed foreign investors to catch fish within its coastal economic zone only to those who agreed to start onshore investment in canneries in view of resource control and job creation to its citizens.

Table 3.3.1 Employment Composition in PNG, Morobe Province and the Project Area

	Employment by Industry			Employment Composition (%)		
	Papua New Guinea	Morobe Province	Study Area	Papua New Guinea	Morobe Province	Project Area
Total	3,272,026	296,314	65,288	100.0%	100.0%	100.0%
Agriculture Hunting and Forestry	2,482,609	216,605	26,017	75.9%	73.1%	39.8%
Fishing	17,679	1,028	183	0.5%	0.3%	0.3%
Mining and Quarrying	24,743	7,277	420	0.8%	2.5%	0.6%
Manufacturing	25,243	4,154	3,446	0.8%	1.4%	5.3%
Electricity, Gas, Steam, and Hotwater	3,734	400	309	0.1%	0.1%	0.5%
Construction	64,147	6,407	4,231	2.0%	2.2%	6.5%
Wholesale, Retail, Repair of Motor Vehicle and Personal/Household Goods	359,223	33,464	12,281	11.0%	11.3%	18.8%
Hotel and Restaurants	6,511	522	443	0.2%	0.2%	0.7%
Transport Storage and Communications	38,952	4,059	2,978	1.2%	1.4%	4.6%
Financial Intermediation	4,931	340	300	0.2%	0.1%	0.5%
Real Estates Renting and Business Service Activities	54,830	6,480	5,362	1.7%	2.2%	8.2%
Others	189,424	15,578	9,317	5.8%	5.3%	14.3%

Source: National Statistical Office

Table 3.3.2 GDP of the Project Area (2011, Estimates)

	Papua New Guinea			Morobe Province			Project Area			
	GDP (PGK million) (A)	Percent to GDP (B)	Employment (persons) (C) = (A) / (B)	GDP per capita (PGK) (C) = (A) / (B)	Employment (persons) (D)	GDP (PGK million) (C) * (D)	Percent to GDP (E)	Employment (persons) (E)	GDP (PGK million) (C) * (E)	Percent to GDP (F)
Agriculture, Forestry and Fishing	6,978	27.0%	2,500,288	2,791	217,633	607,351	15.1%	26,200	73,118	7.7%
Mining, Quarrying and Petroleum	7,248	28.0%	24,743	292,926	7,277	2,131,623	53.1%	420	123,103	13.0%
Manufacturing	1,600	6.2%	25,243	63,387	4,154	263,310	6.6%	3,446	218,459	23.0%
Electricity, Gas and Water	542	2.1%	3,734	145,024	400	58,010	1.4%	309	44,766	4.7%
Construction	2,448	9.5%	64,147	38,159	6,407	244,483	6.1%	4,231	161,452	17.0%
Wholesale and Retail Trade	1,945	7.5%	365,734	5,317	33,986	180,718	4.5%	12,724	67,660	7.1%
Transport, Storage and Communication	717	2.8%	38,952	18,416	4,059	74,751	1.9%	2,978	54,848	5.8%
Financing, Insurance, Real Estate and Business Service	136	0.5%	59,761	2,278	6,820	15,533	0.4%	5,662	12,895	1.4%
Community, Social and Personal Services	3,022	11.7%	189,424	15,952	15,578	248,501	6.2%	9,317	148,626	15.6%
Others	1,222	4.7%	-	-	-	189,768	4.7%	-	44,904	4.7%
Total	25,857	100.0%	3,272,026	-	296,314	4,014,050	100.0%	65,288	949,831	100.0%

Source: Prepared by the JICA Study Team based on data from the National Statistical Office.

CHAPTER 4 SOCIAL CHARACTERISTICS

4.1 Population

As Table 4.1.1 shows, the population of the Project Area area approximately 190,000 in 2011, accounting for 2.6% of the national population and 28% of the population of Morobe Province. The average rate of increase since

2000 has been 2.4%. Moreover, this area has approximately 30,000 resident households, with each household containing 6.17 people on average. In terms of each LLG, household sizes are large in Ahi Rural, Lae Urban, Nabak Rural. The main reasons are considered to be the existence of urban high-density residential areas with low cost houses in Ahi Rural and Lae Urban, and the traditional structure of large-family communities in Nabak Rural.

Table 4.1.1 Population of the Project Area

LLG	Population (persons)			Household (households)			Average Size of Household (persons/household)			Population Density (persons/km2)	
	2000	2011	AAGR	2000	2011	AAGR	2000	2011	Growth Rate (2000=1.00)	2000	2011
Wampar Rural	24,758	35,861	3.4%	4,392	7,923	5.5%	5.64	4.53	0.80	31.9	46.2
Ahi Rural	40,486	60,326	3.7%	6,601	9,523	3.4%	6.13	6.33	1.03	463.2	690.2
Lae Urban	78,692	88,608	1.1%	11,791	12,378	0.4%	6.67	7.16	1.07	1,813.6	2,042.1
Labuta Rural	2,151	4,100	6.0%	347	788	7.7%	6.20	5.20	0.84	37.1	70.7
Nabak Rural	298	542	5.6%	42	78	5.8%	7.10	6.95	0.98	4.5	8.1
Total	146,385	189,437	2.4%	23,173	30,690	2.6%	6.32	6.17	0.98	141.8	183.5

Source: National Statistical Office

4.2 Social Profile and People's Life

4.2.1 Traditional Social Systems and their Negative Impacts

(1) Wantok System

In PNG, there are many small tribal groups, and they are called *wantoks* as the members of a tribe speak the same language. *Wantoks* are composed of clans and families. The *wantok* system acts as a safety-net; however, the system is also negatively exploited to occupy important government posts and to unlawfully provide social services and so on.

(2) Customary Land System

One major reason for lack of development of infrastructure, especially the road network, in PNG is its steep terrain. More than 95% of land ownership is based on traditional customary land tenure, whereby the clans own land and land is orally passed on from one generation to another.

(3) Politics and Governance

The political system of PNG is a parliamentary democracy based on universal suffrage. However, the tribes tend to compete in putting forward their own candidates. The election system are deeply linked to the *wantok* system.

4.2.2 Social Profile and People's Life

The Project Area consists of three districts, namely, Huon Gulf, Nawaeb and Lae Districts. There are five Local Level Government (LLG) jurisdictions allocated within the three districts.

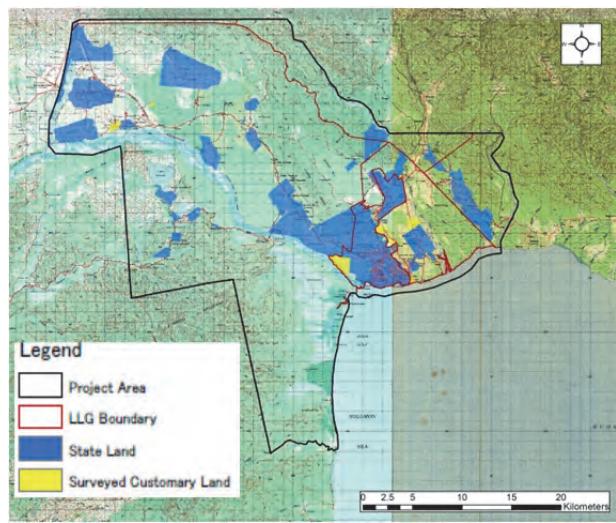


Figure 4.2.1 State Land Distribution

The geographical nature of the area has gifted a variety of agricultural, forestry and fishery potentials; however there is no strong processing industry for those products in the region.



Village houses in Labu Butu

Most houses, except those in Lae City area, are not equipped with toilet facilities nor with water and power supply generally. Many people have migrated to Lae urban area for employment, and they have created large informal settlements of low-income families, the so-called “Settlement.”

(1) Employment and Industries

The employment trend in the Project Area shows that over 25% of rural population are working in agro-production. Those who are employed informally and temporarily account for much higher ratio than those who employed formally. There is a large gap in job opportunities between rural and Lae urban areas.



Typical road side market near Nadzab Airport

(2) Healthcare and Educational Services

Based on the national education system, every child has right to education, but economically it is difficult for many families to let their children to continue attending schools.

Localized healthcare services are limited, and people are struggling for getting access to the services. Most of the facilities are equipped with minimum service equipment and minimum nursing officers or healthcare workers only.

(3) Security and Crimes

There are some aspects that trigger problems among people and communities. Commonly concerned security issues are: Conflicts among clans and land related problems; Ethnic and tribal conflict; Problems with drunken and young people; Unemployment related problems.

4.3 Social Services

4.3.1 Current Condition of Social Service

4.3.1.1 Purpose of Social Service Study

In order to identify the future needs for social service facilities such as schools and healthcare facilities as well as parks and others, the current conditions of such social service facilities are surveyed in this Project through a household survey covering 427 villages within 45 wards. .

4.3.1.2 Current Condition of Educational Service

Morobe Provincial Government and Lae LLG make the highest efforts to provide equal educational opportunity. However, a large number of schools face shortages in both urban and rural areas, and expansion of facilities is needed. The service and facility levels are also not standardized.

4.3.1.3 Current Condition of Healthcare Service

There is a hierarchy of healthcare facilities in the country, and in most cases in Morobe Province the provided healthcare facilities are aid posts with very limited numbers of nursing officers or healthcare workers to attend patients. There are needs to improve services and facilities to provide equal and quality services to the people.



Bubia Health Center, Bubia (ADB/JICA)

4.3.1.4 Current Condition of Other Public Services

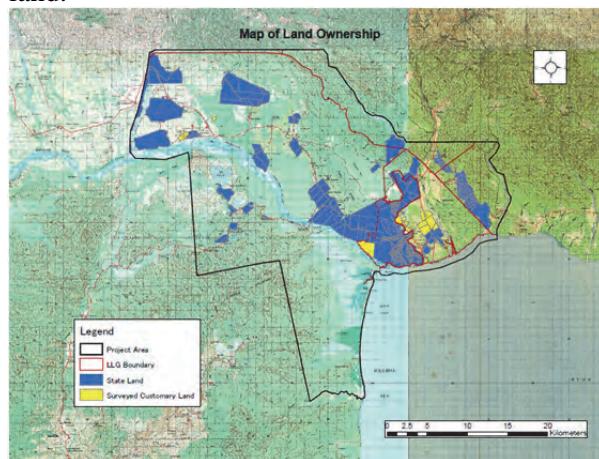
There are several other publicly operated facilities in the Project Area, but they are not effectively maintained or serviced. Moreover, operation programs are not well designed so that the use of the facilities is not effective. These facilities include the following:

- Community centers, ward houses, etc.
- Public facilities, such as libraries, sport fields, parks and others
- Police stations and others.

CHAPTER 5 CURRENT LAND USE AND TENURE

5.1 Land Tenure

Land use control over the customary lands is virtually hard in PNG. After Land Group Incorporation (Amendment) Act 2009, transferring of land rights can be implemented for customary lands only after the registration of lands by Land Group Incorporation. Owners of the customary land will be able to participate in the scheme where the Minister for Lands and Physical Planning approves with identification of land owners and their intention to develop the land.



Source: DLPP Momase Regional Office

Figure 5.1.1 State and Customary Lands in the Project Area

(3) Current Land Use Map



Source: Morobe Provincial Administration

Figure 5.2.1 Current Land Use Map - 2015

On the other hand, state land is administrated under the Land Act. The Land Act provides the mechanisms by which the state may:

- Acquire land (including customary land); and
- Grant leases in respect of any land.

Table 5.1.1 State and Customary Lands in the Project Area (Unit: km²)

State Land (%)	Customary Land		Project Area
	Surveyed (%)	Not Surveyed (%)	
154.85 (14.6)	10.43 (1.0)	891.37 (84.4)	1,056.65 (100.0)

Source: DLPP Lae Regional Office

5.2 Land Use

5.2.1 Study of Current Land Use

(1) Current land use in Lae Nadzab Urban Development Plan 2005–2015

In “LNUDP 2005–2015,” the study of existing land use was conducted in 2003. From the surveyed area of about 74,100 ha, about 10,300 ha (15%) was used land

(2) Obtaining of the prepared data for Current Land Use Map

The existing land use map of 2015 (Map-2015) was prepared using the digital data of previous land use map (Revised-Map-2003) as the base data for the Project. A review conducted indicated that no major development took place in past 12 years

5.2.2 Land Use Changes from 2003 to 2015

(1) Land use changes

The land use changes from 2003 to 2015 have been observed in Lae City and its vicinity. Industrial land and informal residential development expanded to the north part of Lae Central and along Highlands Highway.

(2) Changes of current land use area

Although residential area has not changed so much, informal residential area has expanded about twice, and decrease of traditional village area is observed. Industrial area has increased by about 150 ha.

Table 5.2.1 Land Use Area Change in the Whole Project Area from 2003 to 2015

Land Use Category	Revised-Map -2003	Map-2015		
-Residential	680 ha	6%	690 ha	6%
-Informal Residential	1,120 ha	11%	2,090 ha	18%
-Traditional /Subsistence	1,670 ha	15%	1,390 ha	12%
-Commercial	90 ha	1%	100 ha	1%
-Industrial	290 ha	3%	450 ha	4%
-Public Institutional	720 ha	7%	740 ha	6%
-Open Space	310 ha	3%	290 ha	3%
-Infrastructure	1,140 ha	11%	1,150 ha	10%
-Commercial Agriculture	4,660 ha	43%	4,620 ha	40%
Colored Area Total	10,680 ha	100%	11,520 ha	100%
Project Area	105,670 ha	-	105,670 ha	-

5.2.3 Overview of the Urban Development Projects

Projects of urban development including multiple residential area and industrial park developments have been envisaged and planned aiming for further development in Lae-Nadzab Area.

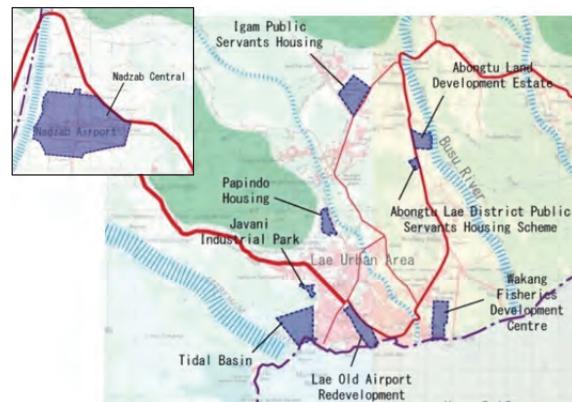
5.2.4 Problems and Development Issues Related to Land Use

(1) Problems related to land use

1) Non-Realization of the LNUDP 2005–2015

Majority of future urban development areas which were proposed in LNUDP 2005–2015 has not been realized.

Industrial development in the Tidal Basin hinterland, Lae Old Airport Redevelopment and Nadzab Airport City are not realized yet.



Source: JICA Project Team

Figure 5.2.2 Urban Development Project in Lae-Nadzab Area

2) Expansion of informal settlement with poor living environment

Massive informal settlements were formed at the foot of Atzera Range, Highlands Highway roadside, on the west side of Ahi Rural LLG, etc. These areas lack basic infrastructures.

3) Lack of land use zoning which enables individuals' establishment

Places for industry establishment are limited to the industrial areas, and it is difficult to proceed with using land by the individuals' effort of small and medium-sized industries.

4) Inhibition of the urban growth

There is very limited room for development along Highlands Highway because of the wetlands and mountain. There is low flexibility to connect districts with each other.

(2) Issues of the urban development in accordance with the land use

1) Issues for urban growth

It is useful to form a network that can flexibly connect all the districts. For this purpose, being aware of the traffic of migratory, it is effective to develop the urban road network like a ladder structure to respond to emergencies.

2) Issues for the improvement of residential environment and Industrial growth

Providing affordable housing, introducing mixed land use for ease of urbanization, and creating variety of recreational areas for expansion of daily activity, etc. are worthy of examination.

CHAPTER 6 EXISTING INFRASTRUCTURE & SERVICES

6.1 Land Transport

6.1.1 Profile of Land Transport

(1) Institutional Framework

Table 6.1.1 shows the organizations involved in the Road Transport Sector in Lae-Nadzab area and their major activities. Table 6.2.1 lists existing major road transport projects.

Table 6.1.1 Institutional Framework of Road Transport Sector

	Organization	Department	Major Activities
1	Depart-m ent of Transport		- Formulation of transport policy and planning
		Land Transport Division in Lae	- Vehicle inspection - Registration of large inter-provincial vehicles (>40) - Registration of automobile dealers
		Road Safety Council in Lae	- Traffic safety training - Traffic controlling
2	Depart-m ent of Works		- Management of national road assets - Development of Engineering Standards
		Northern Regional Office in Lae	- In charge of Momase Region
		Moroibe Provincial Office in Lae	- In charge of Morobe Province
		High Impact / Infrastructure Development Authority Project Office	- Rehabilitation & maintenance of infrastructure - In charge of management of Highlands Highway Project
3	Moroibe Provincial Administra-tion	Division of Works & Transport	- Planning, implementation and maintenance of provincial roads
		Traffic Registry	- Registration of vehicles, PMV, and large inner-provincial vehicles - Driving licensing
4	Lae Urban Local Level Govern-m ent	Engineering & Technical Services	- Planning, implementation and maintenance of Lae city roads (upgrading Lae city roads is currently undertaken by DOW)
5	Traffic Police	Lae Office	- Dealing with traffic accident - Traffic Management

Table 6.1.2 Existing Road Transport Projects

	Project	Finance	Contra-ct or	Current Situation
1	Reconstruction of part of Highlands Highway (35 km, between Lae Port and Nadzab Airport)	DOW	China Railway Internati onal	Under construction

	into four lanes			
2	Bukawa Road (25km) Rehabilitation Pilot Project for JICA technical cooperation project using machineries donated by JICA	DOW	DOW	Under construction
3	Lae City Roads Upgrading to Concrete Pavement (8+27=35km)	DOW	Several contractors	Completed up to Stage-3 (2014 project) and waiting for budget allocation of Stage-4

6.1.2 Present Condition of Land Transport

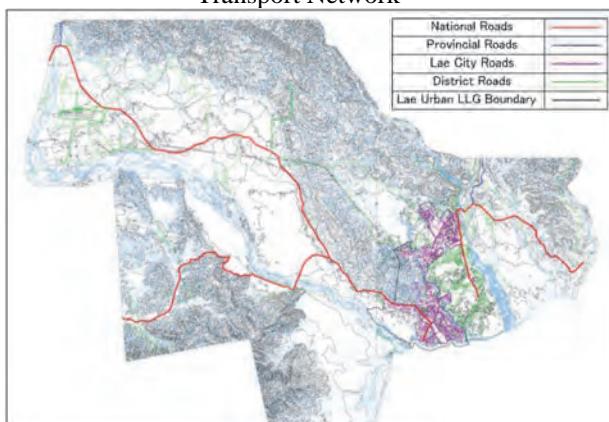
(1) Existing Land Transport Network

Figure 6.1.1 shows the transport network in Morobe Province. The broken lines in the figure show future roads proposed in the Morobe Provincial Integrated Development Plan.



Source: JICA Project Team based on Morobe Provincial Integrated Development Plan

Figure 6.1.1 Morobe Province-wide Transport Network

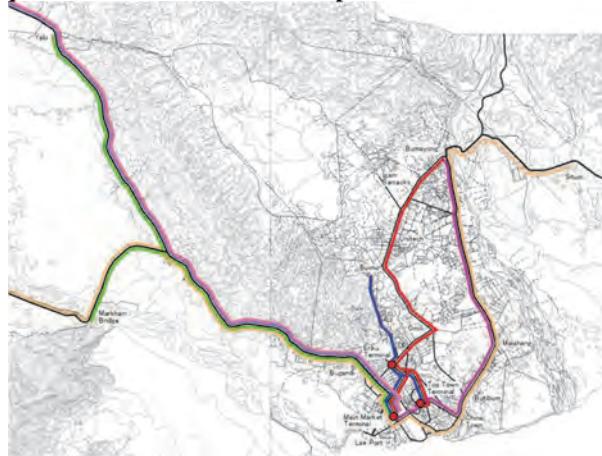


Source: JICA Project Team

Figure 6.1.2 Existing Road Network in the Project Area

(2) Present Condition of Public Transport

There are two types of public motor vehicle (PMV): bus type with 15 or 25 seats, and truck type with 30 seats. Figure 6.1.3 shows pictures of the bus route map.



Source: JICA Project Team

Figure 6.1.3 PMV Route Map

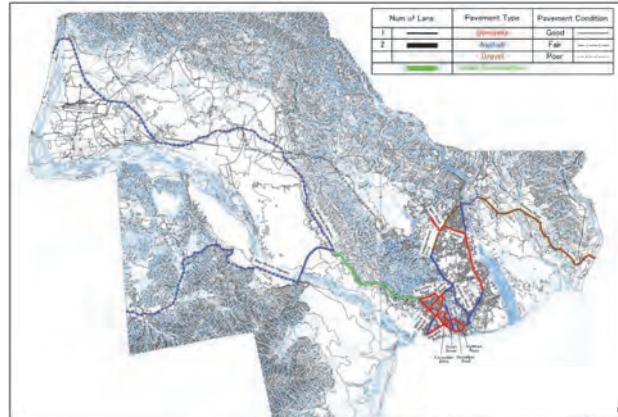
(3) Traffic Management

The Traffic Police is in charge of traffic management; however they have only one vehicle in their office. This makes difficult for the police to conduct the traffic management properly. The lack of proper traffic management, however, is not affecting the traffic flow as the existing traffic volume is not so high.

On the other hand, the Road Safety Council is in charge of actual traffic control and traffic safety training.

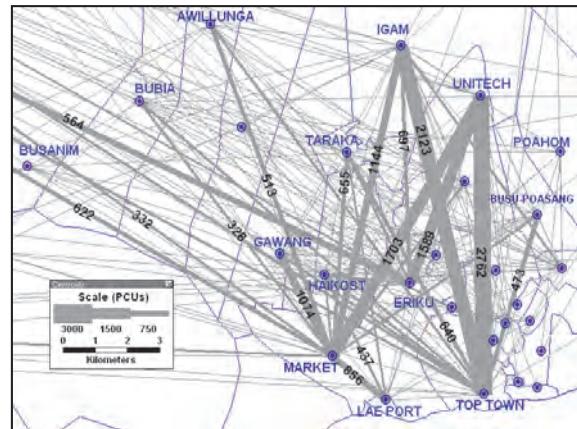
(4) Traffic Volume and OD Trips

The JICA Project Team conducted a road inventory survey on existing conditions of the main roads in the project area, and traffic surveys.



Source: JICA Project Team

Figure 6.1.4 Conditions of Existing Main Roads



Source: JICA Project Team

Figure 6.1.5 OD Desire Lines (Central Area)

(5) Result of Person Trip Survey

The person trip survey was conducted as a part of Household Interview Survey.

The average number of person trips per person is 1.45, and the average number of person trips per mobile person (trip maker) is 2.46.

As the modal split survey result shows, that bus, walk and private car shares are 51%, 26%, and 16%, respectively..

6.1.3 Issues in Transport Sector

Table 6.1.3 Problems and Issues

	Present Problems	Issues to be solved
1	Access between Highland area and Lae City relies on Highlands Highway only	Developing some alternative routes
2	Some main roads have one lane sections (ex. Markham Bridge, Busu Bridge)	Widening one-lane sections
3	Traffic jams in Lae City (ex. Main Market, Eriku)	Improving traffic control system and bus terminals
4	Some main roads are still not paved or seriously damaged	Paving unpaved or seriously damaged roads
5	Access of some areas (ex. Labu, Situd) depends on the weather	Improving the access routes
6	Vessel congestions in Lae Port	Relocating the fishery wharf

Source: JICA Project Team

6.2 Maritime Transport

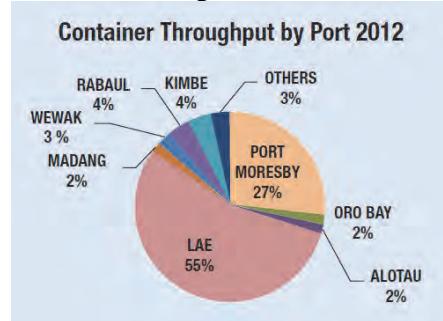
6.2.1 Cargo Service

Cargo services are provided by PNG Ports Corporation connecting to foreign countries and PNG national ports, and also provided by private sectors (e.g. Morobe Coast Shipping Services Ltd., South Sea Lines Ltd.) connecting to major cities around Lae.

PNG Ports Corporation is the agency delegated with the responsibility for maintenance and development of the government owned port facilities and for the general management of

activities within the defined port limits of the declared ports under the Harbors Act.

Lae Port is by far the most important due to its position at the end of the Highlands Highway serving the five inland provinces, and handles almost half of all cargo across PNG wharves.



Source: PNG Ports Corporation Annual Report 2012

Figure 6.2.1 Cargo & Container throughput of All Ports

The Lae Tidal Basin Project has been commenced in May 2012 and its first phase was completed in December 2014 and started service. The profile of the first phase of the project is as follows:

Lae Tidal Basin Project Phase 1

Implementing Agency: Independent Public Business Corporation (IPBC)

Project Period: May 2012 – December 2014

Contractor: China Harbour Engineering Company (CHEC)

Contract Type: Design and Build

Total Cost: K 809 million

Funding Source: 85% from Asian Development Bank and 15% from Government of PNG



KEY 1 Extension of Tidal Basin, 2 Extension of Wharf, 3 Extension of Container Yard

Source: "Lae Tidal Basin Project. Our Future. Our Port." published by IPBC

Figure 6.2.2 Lae Tidal Basin Project Phase 2

6.2.2 Passenger Service

All passenger shipping services are owned and operated by the private sector. There are two major companies providing passenger services from Lae to major cities around Lae. The passenger services to neighboring villages are provided by small boats (dinghy) operated by individual owners/operators.

The current passenger service routes are very limited and there are some major cities isolated from Lae. People nowadays have to go there via Port Moresby by air and it costs a lot.



Source: JICA Project Team

Figure 6.2.3 Passenger Service Route Map (Regular Services)

6.3 Air Transport

6.3.1 Present Condition of Nadzab Airport

Nadzab Airport located approximately 35 km to the west-north-west of Lae is the second largest airport in PNG having 2438 m long runway. Nadzab Airport handled approximately 300 thousand domestic passengers in 2012, and its average annual growth rate from 2008 to 2012 reached 13%. However, it has several deficiencies as listed below:

- Existing runway width of 30 m is not sufficient to accommodate B737 type aircraft;
- Pavement strength of the runway, taxiway and apron is not sufficient to accommodate B737 type aircraft;
- The passenger terminal building is outdated and short of capacity.

Therefore, the airport is not capable of accommodating the increasing air traffic demand properly and efficiently.

6.3.2 Rehabilitation Project

Under the above circumstance, GOPNG has been considering a possibility to borrow Yen Loan for the rehabilitation of the airport, and JICA has decided to implement the “Preparatory Survey on the Project for Nadzab (Lae) Airport Rehabilitation”. The survey was commenced in April 2014 and its final report was submitted in March 2015.

The loan agreement was signed in October 2015 between GOJ and GOPNG, under which GOJ will provide K 578 million and GOPNG will provide K 114 million. Following the loan agreement, JICA and National Airport Corporation signed the project memorandum in December 2015. The project is scheduled to start in March 2016 and be completed in August 2020.

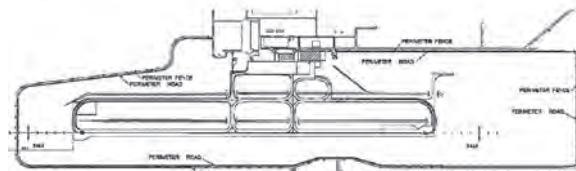


Figure 6.3.1 Preliminary Image of Nadzab Airport Rehabilitation

6.3.3 Airport Traffic Forecast

The preparatory survey forecasted the domestic and international traffic of the airport as shown in Table 6.3.1 and Table 6.3.2, respectively.

Table 6.3.1 Estimated Domestic Passenger Movements

Year	Annual Domestic Passenger	Peak-day Domestic Passengers	Peak-hour Domestic Passengers (Two-way)
2021	600,000	1,840	240
2026	718,000	2,200	290
2031	858,000	2,630	340

Source: Preparatory Survey Report

Table 6.3.2 Estimated International Passenger Movements

Year	Route	Weekly Passengers	Weekly Aircraft Movements	Annual Passengers
2021	Brisbane	240	2	12,400
	Cairns	-	-	-
	Total	240	2	12,400
2026	Brisbane	280	2	14,600
	Cairns	100	2	5,200
	Total	380	4	19,800

Year	Route	Weekly Passengers	Weekly Aircraft Movements	Annual Passengers
2031	Brisbane	480	4	25,000
	Cairns	120	2	6,200
	Total	600	6	31,200

Source: Preparatory Survey Report

6.4 Water Supply

6.4.1 Profile of the Water Supply Sector

(1) Type of Service

The type of water supply services provided in Lae-Nadzab area is divided into two categories: (1) Water Supply System, and (2) River water and/or rain water usage.

These categories are further sub-categorized as piped water supply system, on spot water supply system, river water usage, and rain water usage. However, “Water PNG”, which is a public corporation dealing with water supply and sewerage services in urbanized areas nationwide, is managing the water supply system only in Lae City and the target area of this Project, and other water supply facilities are managed locally.

MPA and LULLG have a section for water supply, but they are not directly involved in the water supply related construction, and operation and maintenance for communities.

(2) Law and Regulations (background law and regulations)

The development and distribution of clean and safe water to communities in both villages and towns are the major issue in PNG. To address issues relating to water resources regulation, drinking water quality standards, and regulation of operations, the Government vested various responsibilities with three institutions. These are the Department of Environment and Conservation operating under the Environment Act 2000, the Department of Health under Public Health Act, and Water PNG under National Water Supply and Sewerage Act 1986.

(3) Organization (construction, operation and maintenance)

1) Water PNG – Lae City

The Lae City branch of Water PNG has 80 staff members. Water PNG - Lae City, which is placed under the Customer Services of the Head Office of the Water PNG, is divided

into four sections to manage the water supply and sewerage services

The present tariff of Water PNG for water supply is shown in Table 6.4.1. The tariff is set uniformly regardless of the customer types.

Table 6.4.1 Water Supply Tariff

No	Effective until 5th November 2015		Effective from 6th November 2015		Remark
	Service	Tariff (PGK)	Service	Tariff (PGK)	
1	Water Supply				
1.1	0 to 12 Kilolitres	16.00 (minimum charge)	0.1 to 20 Kilolitres	0.30 per kilolitre	
1.2	Above 12 Kilolitres	5.10 per kilolitre	21 to 40 Kilolitres	4.80 per kilolitre	
1.3	Water Tankers per 10 Kilolitres	51.00 per 10 kilolitres	41 to 100 Kilolitres	5.10 per kilolitre	
1.4	---	---	Over 100 kiloliters	5.77 per kilolitre	
2	Connection Fees				
2.1	Standard Connections	Water Free	Standard Connection s - Water	Free	
2.2	Non Standard Connection	Water at cost	Non Standard Connection - Water	At cost	
2.3	Reconnection - water	72 per reconnection	Reconnecti on – Water	At cost	
3	Standby Fees				
3.1	Standby Fees - water	2.22 per Kiloliters	Standby Fee – Water	At cost	Note-1

Note-1: Standby fee is the charge to private sectors having private wells.

Source: Water PNG

2) Other Organizations

Except Water PNG, Defense Force, Nadzab Airport, Local Government Authorities, and some industries have their own water supply system and manage the water supply facilities. And some communities have also their own water supply facilities. However, those facilities are not meet with the demand and the quality standards, and many communities are getting the water from river and/or rain directly.

6.4.2 Present Condition of the Water Supply Sector in Lae City

Water PNG has 7,770 customers (December, 2015). There are three types of household customers, which account for approximately 90% of the total number of customers. The remaining main customers are: industrial (approximately 7%), commercial (approximately 1%), and institutional, including hospitals, schools and public

buildings (approximately 2%).

The water consumption for industrial use is rapidly increasing since water consumption by each customer has been large. This implies that a small increase in the number of customers affects the total amount of water consumption and industrial development leads to a drastic increase in water consumption and lack of water treatment capacity.

Currently, Lae City branch of Water PNG has seven boreholes for intake water facilities, and has a water treatment plant (WTP) called “Taraka Treatment Plant”. It is a plain chlorination water treatment plant that treats the water of seven boreholes. Disinfection is carried out by the application of chlorine gas which is injected into the raw water inlet pipeline prior to entry of the two storages.

Transmission main to Bumayong reservoir is the only transmission independent from the distribution main. Inlet pipes of the other reservoirs are branching from the distribution main, and the water from the WTP cannot be stored in the reservoirs directly. Therefore, the reservoirs cannot be used effectively for the undeveloped transmission mains.

6.4.3 Current Projects and Plans

Water PNG developed a master plan of water supply facilities in Lae City in cooperation with Australia in 2015.

Water PNG is extending pipes by six miles to supply water to a residential area along the Highlands Highway. Moreover, Water PNG needs to expand its water supply area further to meet the water supply demand by the military barrack in the north.

6.4.4 Issues in the Water Supply Sector

(1) Present Problems

PNG is rich in water resources due to its high rainfall. Water PNG operates and manages water supply facilities only in urban areas and sightseeing areas, and water supply service is not available in villages scattered throughout the nation, where residents live with rainwater and river water. In the Project area of Lae-Nadzab, water supply is available only in Lae City.

In Lae City, expansion of water supply facilities supported by Australia was based on utilization of existing facilities, and still issues

remain there. For example, distribution pipes are sometimes diverged from transmission pipes, and sufficient water does not reach the reservoir because of low water pressure. Moreover, the revenue water is still not high, which can be improved by replacement of asbestos pipes. At the time of developing the master plan in this Project, solutions to these issues should be considered.

(2) Issues in the Water Supply Sector

After defining the water supply area in this Project, firstly the Project Team needs to set standard values. Secondly, the Project Team should review the entire facility structure, primarily the development of reservoir, and distribution pipe networks. Finally the Project Team can create a master plan.

6.5 Sanitation & Sewerage

Present share and systems adopted in Lae-Nadzab Area are summarized in Table 6.5.1. Since no inventory system is available for the on-site-sanitation, distributions / shares of facilities are assumed according to interview survey of the health inspectors of LULLG, Water PNG and a service provider of sludge disposal for septic tank.

Table 6.5.1 Distribution of Current Wastewater Management System

Category	Sub-category	Service Provider	Main covering areas	Estimated coverage (2015)
Sewerage	Sewerage (with STP)	Water PNG	Taraka	14,184 persons
	Sewer without STP	Water PNG	Most of Lae city except the above areas	14% of Lae city (24% of service population for water supply)
On-site-sanitation	Septic Tank Other private sanitary treatment (Unitech area)	Private sector for sludge disposal Private treatment	Remaining area in Lae city (informal settlement for example) and suburban areas	45,595 persons (76% of service population for water supply)
	Pit latrine and others	Managed by the citizen	Rural areas	150,961 persons Major parts in Morobe Province (Unserved population of water supply)

Source: JICA Project Team

Water PNG is in charge of sewerage development and operation. Nevertheless, on-site-sanitation is managed by the citizens on a self-help basis.

6.6 Power Supply

Currently “Lae Area Distribution Network Improvement Plan” funded by JICA is undergoing. The description of this Section is an excerpt from the “Lae Area (Power) Distribution Network Improvement Plan.”

6.6.1 Outline of Electricity Supply System

The main sources of the power generation are the Ramu Hydro Power Station with an installed capacity of 75 MW, Paunda (2x6MW) and the newly installed 18 MW Yonki Toe of Dam. Diesel generators at several sites supply supplementary power during transmission line outages. Power is also purchased from the privately owned Baiune P/S (about 9 to 10 MW) depending on availability.

The power supply system in Lae area is composed of three electric generation stations, 132/66 transmission lines, several transformer stations. Within the premises of Taraka and Milford substations, diesel power generators are installed. Electricity is supplied through voltage transformer (240/415) on the 11kV distribution and partly 22kV distribution network.

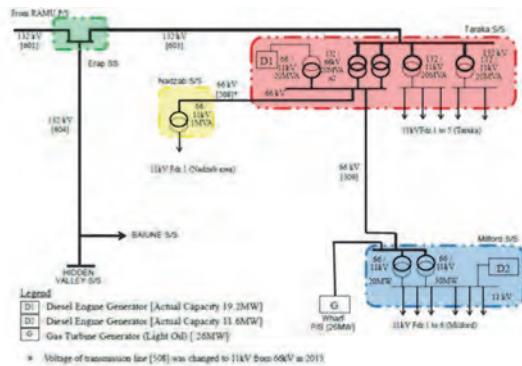


Figure 6.6.1 Outline of Electricity Supply in Lae Area



Figure 6.6.2 66kV Transmission Line

6.6.2 Electricity Demand in Lae Area

Not a large seasonal fluctuation of electricity demand was observed in Lae area.

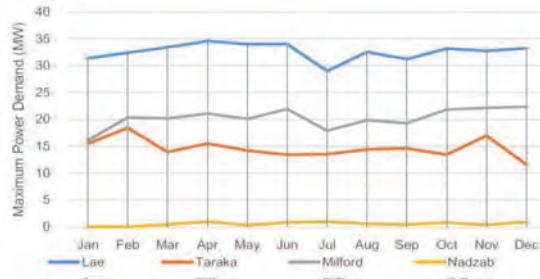


Figure 6.6.3 Maximum Combined Electricity Demand by Substation in Lae area (2014)



Figure 6.6.4 Electricity Demand Density in Lae area (As of Jan. 2015)

6.6.3 Distribution Facilities

Electricity is supplied to the Lae area through twelve 11kV distribution lines from Taraka, Milford and Nadzab substations. There are two boosting transformers on the network: No.1 distribution line from Nadzab Substation and No.6 distribution line from Milford Substation.

Table 6.6.1 Length of 22/11kV Distribution Lines in Lae Area (Unit: km)

	Urban area	Rural area	Total
11kV H.V. line	91	8	99
22kV H.V. line	0	88	88
Total	91	96	187

6.6.4 Problem in Electricity Supply

Power loss in the Ramu system is 21.23%; however composition of power loss was not identified. Blackout in Lae area are mainly caused by rather the facilities (electricity generator, transmission and transformer facilities than distribution network).

6.7 Communication

Currently installed and utilized communication infrastructure is aging, and service charge is

relatively higher comparing with actual services. Common information and telecommunication systems in the region is facing major constraints in terms of market connectivity. Mobile phone telecommunication system has grown very fast, and mobile coverage has increased to 38% by 2012, and fixed phone shared only 1.9% in comparison.

Table 6.7.1 Share of IT Subscriptions

Indicators	2005	2008	2009	2010	2011	2012
Fixed telephone subscriptions per 100 inhabitants	1.05	1.02	1.36	1.77	1.85	1.94
Mobile telephone subscriptions per 100 inhabitants	1.23	13.35	21.15	27.84	34.22	37.78
Estimated internet users per 100 inhabitants	1.72	1.15	1.61	1.28	2.00	2.30

Source: International Telecommunication UNION statistics

(1) Mobile phone

Mobile voice call costs are very high for people, so subscribers more commonly use SNS services. There is more space for service improvement simply from the pricing point of view. Signal coverage is still very limited in urbanized areas or along major roads.

(2) Internet Subscribing

Most mobile phone service providers also have internet data services with several options for users. However, the service charge for internet subscribing is so expensive although the service is not stable and fast as expected. Internet environment in general has to be more developed for better business support and industrial development.

(3) Radio

Radio network is still commonly accepted medium by rural people. Radio broadcasting quality has to be improved to ensure the distribution of certain information such as disaster warning in the region.

(4) TV

TV sets are not highly introduced except in Lae urban area. Not many broadcasting companies are located in Lae, and the service is limited.

(5) News Paper and other paper-based media

People in the region utilize the papers for their information gathering commonly.

(6) Verbal communication

As the most primitive but traditionally trusted way, man to man verbal communication is still supporting many people in Morobe and other regions.

6.8 Solid Waste Management

6.8.1 Profile of the Waste Management Sector

(1) Type of Service

The type of targeted solid wastes in this urban development plan is shown in the table below.

Table 6.8.1 Target Solid Wastes Types in the Plan

Category	Waste Type	Remarks	Target Waste
Solid waste (Municipal waste)	Household waste (domestic waste)	-	✓
	Other municipal waste (commercial and industrial)	Public place and mini markets are included.	✓
Hazardous waste	Industrial waste (hazardous)	Inflammable liquid, etc.	
	Infectious wastes from medical facilities	Hospital, health center, clinic and aid-post	✓

Source: JICA Project Team

(2) Laws and Regulations

In PNG, neither national waste management act nor basic plan on waste management is developed. The Environment Act (2000) is the primary legislation for environmental protection, implemented nationwide by the Conservation Environment Protection (CEPA). This act empowers the provincial and local level governments to develop provincial environmental policies and bylaws on environmental issues, including solid waste management. The Department of Health (DOH) implements the Public Health Act (1973) and Public Health (Sanitation and General) Regulation, which include provisions related to health, sanitation, cleaning, scavenging, waste disposal, and fines for illegal dumping practices. The Organic Law on Provincial and Local Level Governments (1995) empowers provincial and local governments to formulate solid waste management policies, legislations, and bylaws.

6.8.2 Present Conditions of Waste Management Sector

(1) Current Situation of Waste Management Services

The administrative execution of solid waste management is committed to local governments in PNG. LULLG is the only local government that has budget allocated to waste management for waste collection, transportation and dumpsite operation.

(2) Infrastructure

LULLG has a government-own open dumpsite, Second Seven Dumpsite, located in northern area of LULLG. All solid wastes generated in the district are disposed of at the dumpsite in principle.

6.8.3 Current Projects and Plans

There is no existing project or plan of waste management conducted by governmental institutions in the Project area.

6.8.4 Issues in Waste Management Sector

(1) Present Problems

The following problems were revealed.

1) Undeveloped Waste Management System
Except for LULLG, local governments do not provide any services concerning waste management such as waste collection, transportation and final disposal site. The main reason is their budgetary constraints.

2) Inappropriate Operation at Second Seven Dumpsite
Due to budgetary constraint, there is no equipment necessary for appropriate waste landfill implementation at Second Seven Dumpsite.

3) Illegal Dumpsite

Wastes of all mini-markets are disposed of indiscriminately at the side of each mini-markets without any attempt for collection and disposal. Wastes in planned settlements like East and West Taraka, Kamkumu, Miles, Bumayon, villages and compounds in the city throw waste into drains and rivers which end up at seashore during heavy rain.

4) Inappropriate Treatment of Hazardous Waste
Hazardous waste have no proper handling, storage, collection and disposal plans.

(2) Issues in Waste Management Sector

1) Rehabilitation of Second Seven Dumpsite

The existing official dumpsite should be rehabilitated with necessary equipment and improved with appropriate method.

Semi-aerobic landfill method (Fukuoka Method) can be applied with low cost by using local materials. The method is very effective in reducing methane emission with high greenhouse gas emission factor due to semi-aerobic system, and the air pollution caused by combustion of wastes could be significantly improved.

2) Expansion of Solid Waste Collection Area

There are more than 10 illegal dumpsites with no control at mini-markets in the Project area. On the other hand, wastes are thrown into drains and rivers in a lot of places, which end up at seashore during heavy rain. According to population increase, the impacts on environment should be significant in the near future. To solve this waste-related issue, the collection area of solid waste should be expanded to other rural areas in cooperation with LULLG.

3) Promotion of 3R (reduce, reuse and recycling) Activities

For reducing organic wastes, local government should take actions to disseminate the 3R activities at schools and public facilities. If those organic wastes are segregated and utilized at farms and gardens, the waste amount would be reduced by about 40% and collection efficiency would be considerably improved so that further collection area/points could be covered.

4) Development of Recycling Market (Plastics and Papers)

There is no recycling market of plastics including PET bottles and used papers in the area. In the future, development of such recycling market of plastics and papers are highly expected.

5) Improvement of Waste Collection and Transportation Systems

To improve the waste collection and transportation systems, basic data concerning solid waste generation and transportation system should be analyzed in Lae District as soon as possible.

6.9 Disaster Management & Strom Water Drainage

PNG is vulnerable to a various natural hazards. The Government of PNG recognizes the country's vulnerability to natural disasters and is committed to reducing those disasters.

6.9.1 Disaster Management

PNG has a National Disaster Act and supporting National Disaster Plan prepared in 1987. The disaster management system is headed by the National Disaster Committee (NDC), responsible to Cabinet, and the National Executive Council (NEC). The NDC is composed of the secretaries of selected departments, chaired by the Secretary of the Department of Provincial and Local Government Affairs (DPLGA), and is composed of seven vice ministers and two donor representatives under the guidance of the NEC. The current situation is inadequate concerning the meteorological observation network and evacuation warning system.

The National Disaster Center is a subordinate organization of the NDC. Moreover, the NDC is linked to the Provincial Disaster Centers and District Disaster Centers at the provincial and district levels. The organization is currently composed of 16 personnel. The related plans for the disaster management are as given below:

- National Disaster Management Plan (under review)
- National Response Action Plan
- Provincial Emergency & Disaster Plans
- Contingency Plan

6.9.2 Morobe Disaster Management Structure

The Morobe Province is prone to natural disasters especially floods, landslide and earthquakes. Recognizing vulnerability of the province to various kinds of natural disasters, the Provincial Disaster Centre, an office chaired by the Provincial Administrator and headed by the Disaster Director, was established in 1995. The purpose of the center is to collaborate with other stakeholders in development of interventions leading to disaster risk reduction and disaster management on all natural hazards. The Morobe Disaster Centre is recognized by the Government as the only major coordinating

and responsible body in disaster management in the Province under the Disaster Management Act.

The major functions of the Morobe Disaster Centre are as follows:

- Response to and coordination of all types of disasters in the Province
- Responsible for detailed planning and execution of relief operations
- Carrying out initial damage assessment
- Coordinating search and rescue operations (SAR)
- Coordinating all mitigation activities with the communities
- Coordinating stockpiling of relief supplies
- Carrying out public awareness on disaster issues and warnings
- Liaising with stakeholders, NGOs and churches in the disaster management of the Province
- Constant liaising with National Disaster Centre

The Disaster Centre can be very effective in disaster management in the province for its quick response with support from the Morobe Administration and the National Disaster Centre as well as with constant liaising and support from its Disaster Management Partners.

In March 2011, Morobe Provincial Government prepared the action plan for disaster risk management and climate change adaptation with SOPAC by financial support of UNDP. It is still draft and revised progressively. As of July 2015, the Provincial Disaster Management Plan is not yet finalized. The standard operation procedure (SOP) during or post-disaster of related committee members has to be prepared as soon as possible.

Provincial Contingency Plan is prepared to establish disaster resources for forward planning to ensure the efficient, effective and prompt management and control of natural disasters in the Morobe Province.

6.9.3 Natural Hazards in Lae-Nadzab Area

The Project Area is also prone to numerous natural hazards such as earthquakes, tsunami, floods, tropical cyclones, landslides/debris flow and coastal erosion by the impact of

climate change including climate variability and sea level rise.

Earthquakes occur due to unstable continuous movements of lithospheric plates such as North Bismarck, South Bismarck and the Indo-Australian plate on which PNG sits.

Landslides and debris flow occur mainly in the Atzera Range and the Busu Mountains.

The Markham River has the biggest catchment area and drains the Markham Plain including much of the swamp area. The Bumbu River and the Busu River have often flooded causing extensive property damages.

Noticeable tsunamis are very rare according to available records. They occur following strong earthquakes and volcanic eruptions. Vulnerable areas are within Solomon & Bismarck Sea. The height of the tsunami waves have not risen due to the deep sea near Lae City.

Surge tidal waves also cause damage to coastlines when low pressure of surge wind or cyclones occurs. Usually high seas result and waves with velocity cause the coastlines erosion, environment damage, property destruction and loss of lives.

6.9.4 Storm Water Drainage

The Storm Water Drainage Systems seem to be developed in large cities such as Lae City; however, they are prone to cause flooding due to lack of scale, clogging by improper maintenance (see the photo below).



Source: Cities and Climate Change Initiative ABRIDGED REPORT

Photo: a small drainage blocked by garbage and soil

The drainage collects rainwater and drains to the large rivers through the small waterways. It is an open channel and seems to be basically made of wet-stone masonry concrete.

6.10 Other Infrastructure Services

6.10.1 Current Condition of Social Service Facilities

In the Project Area, each District has district level social service division, which coordinates with Provincial service divisions for operation and maintenance. Budgets for social service sectors are set by the state government departments, and each should come down to the provincial administration account; however this structure seems fractured.

(1) Current Education Plan and Educational Facilities

The education plan (Morobe Provincial Education Plan 2007–2016) is to specially improve the educational services in the province, and development targets were set to provide equal educational opportunities to all children.

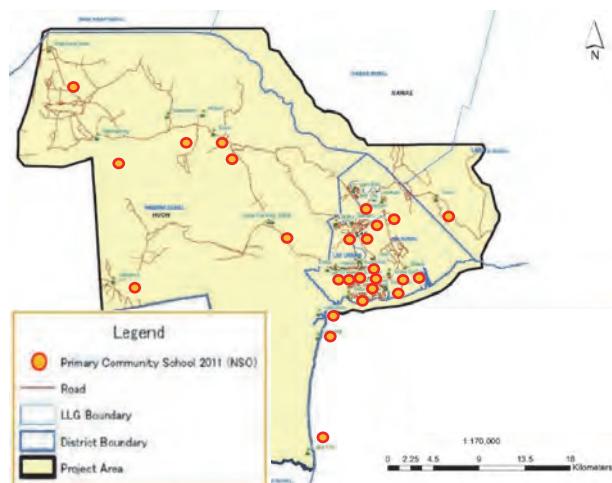


Figure 6.10.1 Location Map of Primary Schools in the Project Area

(2) Status of School Facilities and Services

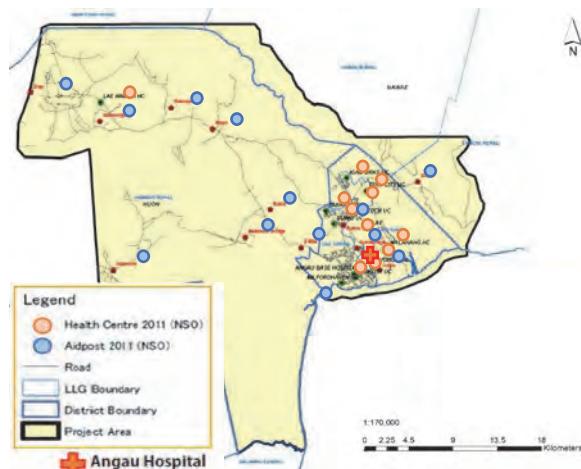
Several existing school facilities were selected for basic site survey, according to the possible development areas considered under the Project spatial planning and programming. The Project team identified that schools need expansion and/or increase of teachers due to over-loaded condition, and many students are forced to walk long distance.

(3) Current Development Plan and Healthcare Facilities

The Morobe Provincial Administration has strategized its healthcare service improvement to provide equal services. However,

insufficient funding from the central government has stalled the improvement activities.

Currently operating aid posts in the region are all classified as Level-1 (L1) service facilities, and most clinics and health centers are classified as Level-3 (L-3), according to the Provincial Health Division. The largest hospital in Morobe Province is Angau Hospital classified as Level-6 (L-6).



Source: JOICA Project Team

Figure 6.10.2 Location Map of Healthcare Facilities in the Project Area

(4) Status of Healthcare Facilities and Services

The healthcare facilities and services must be strengthened in the Project Area in order to meet the needs and demands according to the future development. Site survey of several facilities has been made in order to identify activities with needs and demands at selected facilities.

(5) Other Facilities

There are facilities, such as community resource centers, sports facilities and recreational parks developed in the region. MPG and Lae Urban LLG have been developing quite number of public places and facilities in the region; however, the recreational parks, for instance, have not been utilized well or transformed to other functions, since there are no well-organized laws and regulations for urban planning and zoning control.

6.10.2 Issues and Problems

Many issues and problems are identified based on the site inspection and survey, interviewing local residents and quantitative analysis of

social service data (mainly schools and healthcare service facilities) as well as qualitative analysis of the livelihood in the Project Area.

Table 6.10.1 Issues and Problems identified through Site Survey and Analysis

Area of Concern	Description of Issues and Problems
Housing Facility	<ul style="list-style-type: none"> • Power and water supply needed. • Interior space is only divided in a few sections. • Toilet facility needed.
Infrastructure	<ul style="list-style-type: none"> • Branch roads needed to better connect villages and communities. • Power supply needed. • Water supply needed. • Public transportation needed. • More affordable communication system needed.
Employment	<ul style="list-style-type: none"> • Sustainable employment at regular basis needed. • Better markets needed.
Income	<ul style="list-style-type: none"> • Higher and more stable income needed to support family.
Education	<ul style="list-style-type: none"> • School facilities with appropriate capacity needed. • More schools should be developed. • Distance to schools should be shorten for easy attendance. • Secondary schools needed in closer location for children.
Healthcare Service	<ul style="list-style-type: none"> • Healthcare facility nearby is not efficient in both quality and capacity. • More Aid posts or centers needed for convenience and accessibility. • More officers and workers needed for better treatment. • Emergency and ambulance service needed.
Others	<ul style="list-style-type: none"> • Convenient and better community gathering facility needed. • Recreational facility for especially kids needed.

Source: JICA Project Team

6.11 Donor Activities in the Project Area

In order to visualize current activities of major donors in the country and the Project Area, the Project Team has consulted Australian Aid, World Bank (WB) and Asian Development Bank (ADB).

Table 6.11.1 Major Donor Funded Projects in Morobe Province and the surrounding Region

Project Type	Donor Agency
Healthcare Service and Facility Development	Australian Aid
Transport Projects	Australian Aid
Governance Supporting Projects	Australian Aid
Youth Employment and Community Grants	World Bank
Upgrading/Development Projects of Highways and Tidal basin	Asian Development Bank
Nadzab Airport Redevelopment Project	JICA
Project for Highly reliable Power Supply to Lae	JICA

Source: JICA Project Team based on the consolation with Donor agencies

(1) The expected effects of the above noted JICA Projects:

1) Nadzab Airport Redevelopment Project

The future expansion of the airport will provide still limited capacity for cargo transportation from or to the region; however foreign business people as well as tourists may come and go through Nadzab area.

2) Project for Highly reliable Power Supply to Lae

The power supply project under the master plan will also highly contribute to the improvement of livelihood of local people in the Project Area, and security should be upgraded as well.

CHAPTER 7 POLICY CONTEXT

7.1 Existing Goal, Vision, Policy, Strategies, Plans and Legislation Related to Urban Development

The Constitution of Papua New Guinea (PNG) proclaims the following five national goals and declares directive principles for respective goals:

- 1) *Integral human development*
- 2) *Equality and participation*

- 3) *National sovereignty and self-reliance*
- 4) *Natural resources and environment*
- 5) *Papua New Guinean ways*

Existing vision, policies, strategies, and plans related to urban development are shown in Table 7.1.1. Lae District, Huon Gulf District and Nawaeb District formulated Development Plan with a target period of 2013–2017 based on PNG Development Strategic Plan 2010–2030 and Medium Term Development Plan 2011–2015.

Table 7.1.1 Existing Vision, Policy, Strategies and Plans Related to Urban Development

Vision/Policy/ Strategy/Plan	Contents
PNG Vision 2050	The Vision defines a mission, key pillars, critical enablers and development indicators/trackers with key outcomes of 1) <i>Changing and rehabilitating the mind-set of the people</i> , 2) <i>Having strong political leadership and will power</i> , 3) <i>Improvement in Governance</i> , 4) <i>Improvement in service delivery</i> , 5) <i>Improvement in law and order</i> , 6) <i>Development of strong moral obligation</i> , and 7) <i>Rapid growth potential</i> .
PNG Development Strategic Plan 2010-2030	The Strategic Plan includes strategies of 1) <i>Strategies for Economic Corridor Development</i> including <u>Morobe-Madang Corridor</u> , 2) <i>Strategies for Land Development</i> and 3) <i>Strategies for Urban Development</i> .
National Strategy for Responsible Sustainable Development	The Strategy calls for a paradigm shift towards sustainable development and introduces the enabling dimensions of 1) <i>A national green growth plan to create enabling conditions</i> , 2) <i>Green growth main streaming mechanisms to ensure opportunities through existing economic activities</i> , and, 3) <i>Green growth policy instruments to tap specific opportunities within spatial and resource systems</i> .
Medium Term Development Plan 2 (2016-2017)	The Plan covers only two years to adjust the planning period to match with duration the administration and focuses priority sectors of 1) <i>Planning and Monitoring</i> , 2) <i>Resourcing/Financing</i> , 3) <i>Implementation and Procurement</i> , 4) <i>Priority Infrastructure</i> , 5) <i>Education</i> , 6) <i>Health</i> , 7) <i>Law and Order</i> , 8) Land and Housing , 9) <i>Small and Medium Enterprises</i> , 10) <i>Agriculture</i> , 11) <i>Subnational Empowerment</i> , 12) <i>Public Sector Reform</i> , 13) <i>State Owned Enterprises Reform</i> , 14) <i>PNG LNG and Sovereign Wealth Fund</i> , 15) <i>Legislative Agenda</i> , 16) <i>Strategic Assets</i> .
Morobe Provincial Integrated Development Plan 2014-2018	The Plan has objectives of a) Good Governance and Management, b) Sustainable and Robust Economy, c) Efficient Infrastructure, and d) Integral Human Development, and proposes six Policy Goal Areas of 1) <i>Good Governance and Management</i> , 2) <i>Institutions and Service Delivery Centers</i> , 3) <i>Physical Infrastructure Development</i> , 4) <i>Robust Economic and Wealth Creation</i> , 5) <i>Integral Human Development</i> , and 6) <i>Networking and Crosscutting</i> . In Policy Goal Areas 4, ten growth centers, including ' <u>Lae Tidal Basin Project</u> and <u>Javani Industrial Park</u> ', are proposed.
National Sustainable Land Use Policy	The Policy proposes of measures of 1) <i>Legislating for the three broad land use zones (development promotion, sustainable rural and conservation areas) to provide an over-arching policy framework for land use</i> , 2) <i>Realigning existing zoning in accordance with purposes of the three broad land use zones</i> , 3) <i>Establishing guidelines, terms of references, codes and practices, and standards of land use planning</i> 4) <i>Applying zoning schedule for sustainable land use planning</i> , 5) <i>Taking stock of all state land and encourage customary landowners to release land for development</i> , 6) <i>Preparation and implementation of Land Management Plan</i> , 7) <i>Facilitation and introduction of a Comprehensive Urban and Rural Zoning Plan</i> , 8) <i>Facilitation of a Comprehensive Development Plan framework for an integrated approach to physical planning system</i> .
National Urbanization Policy 2010-2030	The Policy formulates a) Policy Goals, b) Objectives and c) Policy Statements for key cross sector policy areas of 1) <i>Population and Employment</i> , 2) <i>Transportation and Infrastructure</i> , 3) <i>Urban Environment and Climate Change</i> , 4) <i>Housing and Social Issues</i> , 5) <i>Urban Land Availability</i> , 6) <i>Urban Security, Law and Order</i> , and 7) <i>Institutions and Governance</i> .

Source: JICA Project Team

The Physical Planning Act (1989) and Physical Planning Regulation (2007) set as guidelines on the physical development, management and the best use of land and land resources. They further guide the use and development of land within areas declared as physical planning areas. The legislation provides three categories of development or land use matters that are either exemption from or subject to control under planning system:

- i) Development or use of land that are outside of physical control
- ii) Development or use of lands that are within the sphere of planning control but that are automatically approved via once and for all decisions, or
- iii) Development or use of land that is within the sphere of planning control and requires a specific decision by the authority.

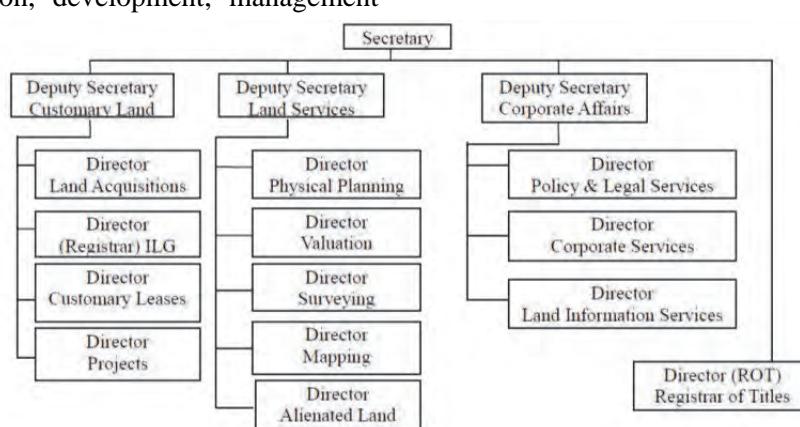
The Physical Planning Act provides the framework for spatial planning. This enables the three levels of government to guide the planned allocation, development, management

and the best use of land and land resources in urban and rural areas (Annex to the National Sustainable Land Use Policy).

Building Act (1971) and Building Regulation (1994) regulate the construction of physical structures. The focus is to regulate the construction of building structures within urban areas. The permanent building structures within the urban areas have been assessed for their standards. They further regulate and control use of a building and the land on which the building is erected, both during and after construction of the building. The Building Boards are established to assess the building plans provided by the developer.

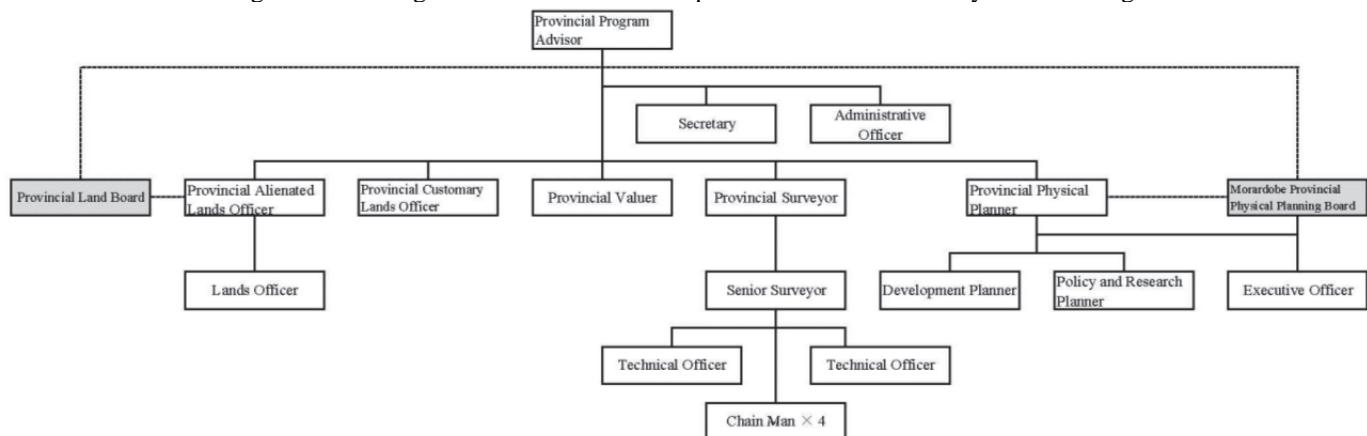
7.2 Administrative System

Organizations in charge of land administration, physical planning and zoning are Department of Lands and Physical Planning at the national level and Division of Lands of Morobe Provincial Administration at the provincial level, whose organization charts are shown below.



Source: Detail Design Survey Report of the Project

Figure 7.2.1 Organization Structure of Department of Lands and Physical Planning



Source: Morobe Provincial Administration

Figure 7.2.2 Organization Chart of Division of Lands of Morobe Provincial Administration

PART II

URBAN DEVELOPMENT PLAN

CHAPTER 8 DEVELOPMENT CONSTRAINTS AND OPPORTUNITIES

8.1 Problem Structure and Development Issues

(1) Problem Structure

- 1) No well-developed urban development method and strategy to deal with traditional customary land.
 - a) Absence of realistic and effective plans

Major problems and difficulties with urban development exist because of customary land ownership system of PNG, and restriction and inducement as well as development cannot be implemented under such traditional system.

 - b) Disorganized urbanization

The absence of development plans with concrete methodology of restriction, inducement and implementation has been influencing the disorganized urbanization, leading to development of informal settlement, disorderly urbanization along or nearby major trunk roads and delay in urban restructuring.

 - 2) Social unrest and unsafe areas in the Study area.

Processing sector utilizing imported goods and materials, such as processed food, processed fish products, cement and milled products are the common activities observed in the area, and such industrial structure does not contribute to job creation. According to the household survey under the Project also indicates higher unemployment rate of 49% in Lae-Nadzab Area.

Such low degree of living condition and high unemployment rate of the Project Area obviously affect the safety of the social environment and make it prone to unrest. Where people from different clan live in the same area, more risk of land related conflicts or crimes could take place as socially unstable community could be developed.

(2) Development Issues

Based on the sector level studies in Lae-Nadzab Area, the following issues and problems are identified.

- 1) Spatial development related issues:
 - a) Strengthening of network between Lae-Nadzab Area and other regions
 - b) Improvement of infrastructure for economic and industrial activities
 - c) Enhancement of communication and information technology in the region

- d) Formation of well-organized disaster management
- 2) Industrial development related issues:
 - a) Strengthening of industrial development and expansion of job opportunities
 - b) Enhancement of well-coordinated infrastructure for industrial activities
 - c) Strengthening of trade and distribution supporting infrastructures
 - d) Restructuring of industrial structure in low school enrollment rate area
- 2) Basic social life infrastructure development issues:
 - a) Improvement of basic livelihood supporting infrastructures
 - b) Enhancement of educational and healthcare services and facilities
 - c) Strengthening of sanitation and waste management
- 3) Informal settlement related issues:
 - a) Improvement of basic infrastructures and public services
 - b) Peacemaking of land and clan tribe related conflicts
 - c) Support for low income families in the settlements with affordable housings
- 4) Institutional issues:
 - a) Strengthening of government officials capacity
 - b) Improvement of operation and maintenance quality and activities in public services
 - c) Formulation of good budget control system in local governments

8.2 Development Constraints

As constraints to urban development, natural constraint condition and organizational constraint condition are discussed hereafter.

(1) Physical Constraints

1) Mountains (Atzera, Busu Mountains)

Atzera Mountain is located only about 8 km away from Lae city, and it has about 1,300 to 1,500 m in altitude.

2) Rivers (Markham, Erap, Busu, Butibum, Bumpu, Bupu and Bunga Rivers)

All rivers in the Project Area are naturally formed, and flood protection measures with man-made structures have not yet been made except on Markham River. River beds are high and width is about 500 to 1,000 m wide, and they have been shifting around the area in the last few decades according to the satellite photos.

3) Sea (Huon Gulf)

The Huon Gulf is marked with international sea lines and coastal lines. The coast line along Labu area is currently seriously eroded, losing beach line.

4) Flood plains and swamps

There are series of flood plains situated in the Project Area, such as the area between Nadzab Airport and Markham River, the north area of Lae Port and the area along Busu and Bupu rivers. The area along Bumpu River in Lae City is also identified as a hazard area which requires countermeasures against flood.

(2) Institutional and Legal constraints

1) Poor city management structure

The city of Lae suffers from multi-layered management issue as the Provincial, District and Local Level Governments have roles in management and administration of the city.

2) Difficulty in customary land development along the urban development plan

Identifying of the ownership and clear boundary of the customary land is difficult with the modern system. This situation is making difficult for customary land owners to obtain bank loans.

8.3 Opportunities

Based on the analysis of the current issues and problems for Urban Master Planning in Lae-Nadzab Area, the following future development opportunities are identified.

(1) Potential of local natural resources

There are large opportunities to utilize existing natural resources, including mineral resources, natural gas, wide range of agro-products including grains, vegetables and cash crops, such as coffee and cacao. These resources could help there region to shift its industrial basis from import oriented to export oriented in the long-term development.

(2) Potential of existing land, particularly customary land

There are large amount of undeveloped land in the Project Area which are owned by clans. Applying the best integrated development and laws and regulations to best control urban development, such undeveloped open land should become large potential to the region.

(3) Potential of industrial and distribution center under government initiatives

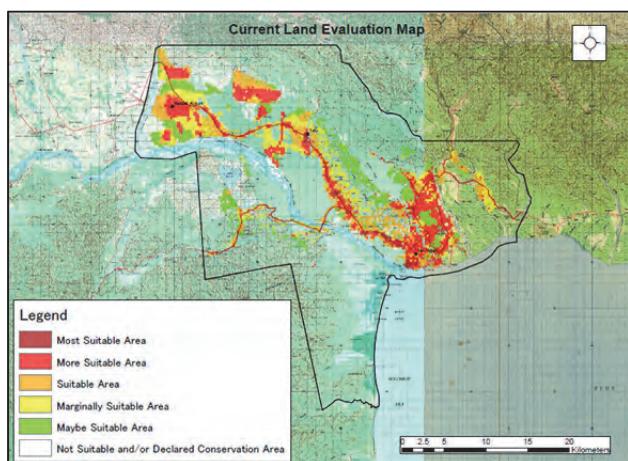
The central as well as provincial governments have united concept for the Lae-Nadzab Area development in which the area will be developed as the industrial and distribution center of the PNG.

(4) Potential of wide area transportation network

The regional development vision and actual development of several large scale infrastructures, such as Lae Port expansion, Highlands Highway improvement and Nadzab Airport development, should become real core of the “transformation” of the region into industrial and distribution center.

8.4 Creation of Land Potential Map for Development

Land development potential map was created by overlay method of thematic maps, including (a) flood prone area, (b) good environmental conservation area, (c) steep slope area, d) urban land use, (e) agricultural land use area, (f) state land area, (g) accessibility to city centers, (h) accessibility to main roads. 250 m mesh data were created and each mesh was scored from the viewpoint of land use potential.



Source: JICA Project Team

Figure 8.4.1 Current Land Evaluation Map

The suitable areas for development were identified around Lae city, Yalu area and Nadzab Airport area.

CHAPTER 9 VISION AND FRAMEWORK

9.1 The Vision for Lae-Nadzab Area

The vision for best development effect to Lae-Nadzab Area has been set considering industrial development concept as well as urban development concept that are in line with the several national and provincial level development plans.

9.1.1 Basic Philosophy of the Existing Development Plans and Concepts

The following plans are reviewed:

- (1) Papua New Guinea Vision 2050 (PNG Vision)
- (2) Papua New Guinea Development Strategic Plan 2010–2030 (PNGDSP)
- (3) Morobe Provincial Integrated Development Plan 2013–2017 (MPIDP)
- (4) Lae-Nadzab Urban Development Plan 2005–2015 (LNUDP)

Core points concerned under these plans and concepts of central as well as local governments are summarized as follows:

- Lae-Nadzab area should be developed for the nation's future economic growth and its benefit as PNG's future industrial capital.
- The development in Lae-Nadzab area should be achieved for sustainable economic and social improvement and environment-conscious development should be pursued.
- Through the development, wealth creation, security and international relationships should be improved.
- Human resource development and institutional capacity development should be achieved through the development.
- Lae-Nadzab area development should be well integrated with appropriate regulations and norms for strategic planning and development implementation.
- Lae-Nadzab area will be developed as a future model for development of PNG with environmental and nature friendly concept.

Taking these current development activities into consideration, the new development vision

for Lae-Nadzab Area urban Development Master Plan is set forth.

Overall Lae-Nadzab Area Development Vision

“Creation of a Positive Integral Human Livelihood Region”

Lae-Nadzab area with effective and enhanced human resource and institutional capacity will be developed to a sustainable economic activity center of the country realizing the country’s development model with healthier nature and environment consciousness in the safe society.

9.1.2 Concept on Industrial Development Pursuant to the Urban Development Vision

The new Lae-Nadzab Area Urban Development Master Plan shall be the ***driving force*** to the regional industrial, economic and all social activities and their improvement as well as the improvement of the livelihood of the local population. The industrial development vision for the region is:

Lae-Nadzab Area will be developed as the industrial, manufacturing and distribution center of PNG, and will be developed as the Growth Center of the Morobe and surrounding region.

The following activities will be considered as the heart of industrial development:

- Corresponding ideas towards the Growth Center strategy
- Selection of candidate promising industry based on the condition of industrial framework
- Promotion of local investment to support diversity of industry and their development
- Consideration of Lae-Nadzab Area as the gateway to the Pacific region trading market
- Promotion of promising industry by developing industrial agglomeration, and
- Consideration of the Area as the center of transportation hub of industrial corridor

9.1.3 Concept on Lae-Nadzab Area Urban Development Vision

Today, there are many countries, regions and cities targeted by rich investors for development;

however, they do not always have same kinds of dreams to change the developing countries or the cities despite the fact that they often could twist the ways that each place wants to face because of pursuing economic benefit and capitals for their business advantages. To live cooperatively with such capitalism and development forces in the future, the region and Morobe Province should stand intact with their own development vision, which still has same blood from the past living with its rich nature and tradition. Thus, the term “Garden City” is adopted for the new Urban Development Master Plan vision statement.

Lae-Nadzab Area will be developed as the “Garden City” of Morobe as well as PNG.

9.2 Population Framework

9.2.1 Population

As the second largest city of PNG, Lae is expected to grow further in the future and to have a higher population growth rate than the rest of PNG. Future population of the Project Area is estimated based on the three scenarios shown below.

Scenario	Population increase rate p.a.	Basis of setting
Low	2.5%	Same as the population increase rate for all PNG
Middle	2.7%	The same population increase rate as for Port Moresby*
High	2.9%	10% higher than the medium growth case

(*): The average population increase rate of Port Moresby between 2000 and 2011 was 3.3%, and that for PNG overall was 3.1%. Therefore, in the case where the population increase rate for PNG overall is 2.5%, that for Port Moresby will be $1.025 \times (1.033/1.031) = 1.027$, i.e. 2.7%.

Table 9.2.1 shows the results of population estimation in the Project Area. According to the middle case, the population in 2025 will be 1.45 times the 2011 figure, and the population in 2050 will be 2.82 times the 2011 figure at more than 500,000. The high case and low case are 8% more and 7% less than the middle case respectively.

9.2.2 Economic Population (Labor Force)

According to the middle case estimate, the labor force in 2025 will be 1.48 times the 2011 level, which is slightly higher than the 1.45 times estimated for the rate of population increase as shown in Table 9.2.2.

Table 9.2.1 Results of Future Population Estimation in the Project Area

	Population					Growth rate (2011=100)				
	2011	2025	2030	2040	2050	2011	2025	2030	2040	2050
Low	189,437	268,000	303,000	388,000	496,000	100	141	160	205	262
Middle	189,437	275,000	314,000	410,000	535,000	100	145	166	216	282
High	189,437	283,000	326,000	434,000	578,000	100	149	172	229	305

Source: JICA Project team

Table 9.2.2 Estimation of Future Labor Force in the Project Area (Middle Case)

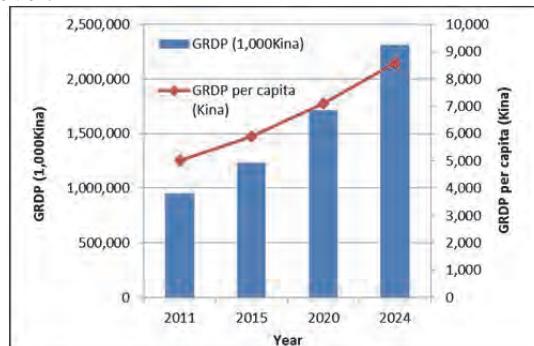
	Economically Active Population					Growth rate (2011=100)				
	2011	2025	2030	2040	2050	2011	2025	2030	2040	2050
Male	42,063	59,400	66,100	83,200	106,400	100	141	157	198	253
Femal	29,973	47,000	54,100	71,900	94,900	100	157	180	240	317
Total	72,036	106,400	120,200	155,100	201,300	100	148	167	215	279

Source: JICA Project Team

9.3 Economic Framework

9.3.1 GDP

Utilizing the above figures, the GRDP and GRDP per capita in the Project Area were estimated as shown in Figure 9.3.1. It is estimated that the GRDP of the Project Area in 2024 will be 2.43 times the 2011 level and the GRDP per capita will be 1.72 times the 2011 level.



Source: JICA Project Team

Figure 9.3.1 Economic Growth Forecast in the Project Area

Table 9.3.1 Economic Growth Forecast in the Project Area

	(A) GRDP PGK 1,000	(B) Population	(A)/(B) GRDP per Capita in PGK (USD)
2011	949,831	189,437	5,014 (1,961)
2015	1,235,000	210,000	5,900 (2,307)
2020	1,717,000	243,000	7,100 (2,777)
2024	2,310,000	269,000	8,600 (3,363)
Re- marks	Based on the NRI annual forecast increase rate	Medium case population forecast result by JPT.	US1=PGK 2.557

Source: JICA Project Team

9.3.2 Household Income

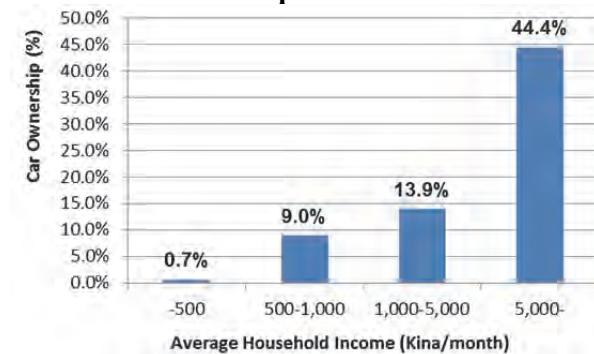
The overall ratio of households with income of less than PGK 500 will fall from 29.5% in 2015 to 19.0% in 2025 and 5.9% in 2050. On the other hand, the ratio of those earning income of more than PGK 5,000 will increase from 1.8% in 2015 to 12.1% in 2025 and 24.8% in 2050.

Table 9.3.2 Forecast of Household Income Ratios
(Monthly Income)

	2015	2025	2040	2050
Under PGK 500	29.5%	19.0%	11.8%	5.9%
PGK 500~1,000	45.7%	25.9%	10.0%	5.9%
PGK 1,000~5,000	23.0%	43.0%	59.1%	63.4%
Over PGK5,000	1.8%	12.1%	19.1%	24.8%
Total	100.0%	100.0%	100.0%	100.0%

Source: JICA Project Team

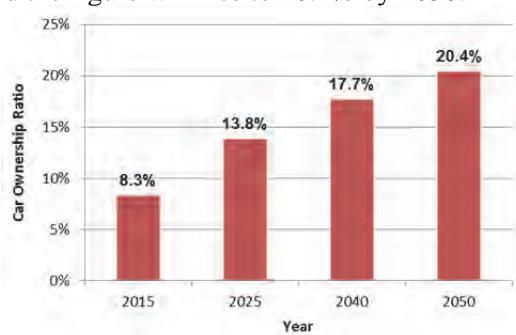
9.3.3 Car Ownership Rate



Source: JICA Project Team

Figure 9.3.2 Relationship between Household Income and Car Ownership

According to the relationship between household income and car ownership, it is estimated that 13.8% of all households will own a car by 2025 and the figure will rise to 20.4% by 2050.



Source: JICA Project Team

Figure 9.3.3 Forecasted Car Ownership Ratio

9.4 Spatial Framework

9.4.1 Population Density Forecast

(1) Assumption of housing density in current situation of Lae City

It should be noted that target neighborhood have roughly ratios of land use; 55% for residential

land, 15% for additional land facilities (such as school, commercial facility, etc.), and 30% for public land (such as for roads, parks, etc).

It is estimated that the housing density is about 11 houses/ha in the neighborhood with the average size of residential allotment of about 500 m²/allotment, and that it is about 9 houses/ha in the neighborhood with the average size of 600 m²/allotment. Population density is then estimated 70–90 persons/ha, assuming 8 persons/household. However, this population density has to be regarded as an average range. The figures actually applied range from 50 persons/ha to 150 persons/ha depending on locations and forms of houses.

9.4.2 Projection of Required Land for Population Growth

(1) Residential land demand and industrial-based land demand

Assuming that the population density will be 60–70 persons/ha, it is estimated that by the year 2025 about 710–830 hectares development land including residential land use is required.

It is estimated that the population in 2050 will be 535,000 people (moderate range estimate). The urbanization is considered to expand to suburbs. Assuming that the population density will be 50–60 persons/ha, it is estimated that about 4,040–4,830 ha development land including residential land use is required.

①: Residential Land Demand Look at 2025 data.

	2000	2011	2015	2025	2050
Total	146,000	189,000	210,000	275,000	535,000
Exceed than 210,000 people of 2015 data					+65,000 +325,000
Assumption : above 2025-15,000 & 2050-75,000 in the not-newly-developed areas and 2050-10,000 within the latter in Lae central area will not require any lands.					
Residential Land required : Densities assumed more than Lae Examples.					
cf. Lae Examples of Current Housing Densities at Superblock or Neighborhood :					
Formals (family 8) : 72 people/ha - 9 houses/ha (= 1100m ² /house)					
Informals (family 8-10) : 62 people/ha - 6.3-7.7 houses/ha (= 1300-1600m ² /house)					
<input checked="" type="checkbox"/> Residential Lands required at 2015-2025 : 65,000-15,000+50,000 <+50,000 people> ÷ 60-70 people/ha = 710-830 ha					
<input checked="" type="checkbox"/> Residential Lands required at 2025-2050 : 325,000-75,000-50,000=200,000 <+200,000 people> ÷ 50-60 people/ha = 3330-4000 ha					
<input checked="" type="checkbox"/> Required Land area at 2015-2050 : total area 4040-4830 ha					

Source: JICA Project Team

Figure 9.4.1 Demand for Residential Land from 2015 to 2050

Based on basic unit of required land per employee for commerce and industry, it is estimated that by the year 2025 the demand for industrial-based land will be about 260 ha. It is similarly estimated that by the year 2050 the demand for industrial-based land will be about 1,210 ha.

②: Commercials & Industrials of Land Demand					
	2003	2011	2015	2025	2050
Commercials	92 ha 17,200+α	95 ha 21,400	100 ha 23,200	120 ha 30,400	210 ha 59,100
C-Land per capita	approx.50 m ²	44 m ²	43 m ²	40 m ² ?	35 m ² ?
Industrials	286 ha 6,300+β	380 ha 11,000	450 ha 13,500	690 ha 23,000	1550 ha 62,000
I-Land per capita	approx.360 m ²	345 m ²	333 m ²	300 m ² ?	250 m ² ?
Total	378 ha	475 ha	550 ha	810 ha	1760 ha
Exceed than 550 ha of 2015 data					
			+260 ha	+1210ha	

**Commercials are a little increasing,
Industrials are much increasing.**

cf. Industrial Land Use seem almost 160 ha(=450-290) for total study area and also almost 90 ha(=340-250) increasing for Lae city area (including Ahi rural area) during 12 (2003-2015) years.

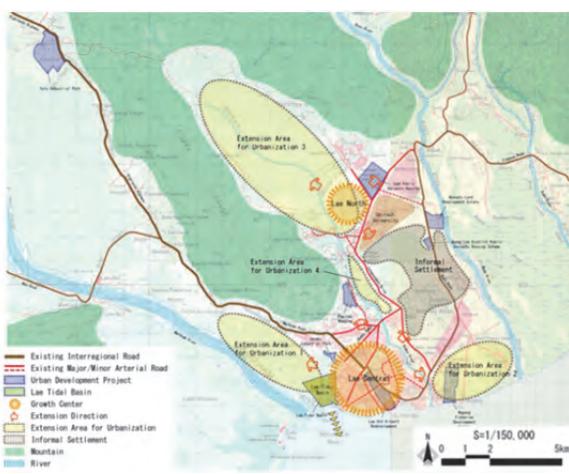
Source: JICA Project Team

Figure 9.4.2 Commercial & Industrial Land Demand from 2015 to 2050

9.4.3 Distribution of Population and Required Area for Land Development

(1) Direction of urbanization expansion until 2025 and 2050

Considering that the urbanization will expand only to areas around Lae City until 2025, it is assumed that the following unused lands will be urbanized: (i) the hinterland of Tidal Basin where the main port is located, (ii) around Wagang where fishing port development is planned, (iii) around envisioned Yalu-Igam Bypass, and (iv) western side of Independent Drive connecting Lae Central and Lae North. Regarding Nadzab Airport area, the feasibility study is yet to be conducted, and the area will need several years to fully develop; thus there will be a small scale developments only in relation with the airport service related facility in the area.



Source: JICA Project Team

Figure 9.4.3 Direction of Urbanization Expansion until 2050

(2) Distribution of Future Population

Increased population is distributed in Developed Area and Other Area based on future population estimates by LLG. It is estimated that about 80% of population increase is to live in the future Developed Area. Since population increase in Informal Settlement is expected, population increase does not only occur in Developed Area. Therefore, efforts to properly induce residence in Developed Area are required.

Table 9.4.1 Distribution of Future Population to Developed Areas in LLGs

LLG	2015	2025	2050
Lae	93,000 persons	103,000 persons (D 9,000 ; O 94,000)	130,000 persons (D 26,000 ; O 104,000)
Urban	41,000 persons	72,000 persons (D 27,000 ; O 45,000)	232,000 persons (D 166,000 ; O 66,000)
Wampar	70,000 persons	90,000 persons (D 14,000 ; O 76,000)	140,000 persons (D 58,000 ; O 82,000)
Ahi	6,000 persons	10,000 persons (D 0 ; O 10,000)	33,000 persons (D 0 ; O 33,000)
Rural			
Total	210,000 persons	275,000 persons (D 50,000 ; O 225,000)	535,000 persons (D 250,000 ; O 285,000)

*D = Developed Area, O = Other Area (Existing Area and other Area)

Source: JICA Project Team

(3) Distribution of Required Land Area for Development

Taking the population into account, future development strategy until now has allocated to each LLG for necessary development scale that was estimated earlier for each of the Developed Area and Commercial & Industrial Development Area. However, with a view of small-scale development in Nabak LLG and Labuta LLG, 10 ha development scale is expected.

For the time being there is a need to focus on Commercial & Industrial Development. Various elements in relation to Commercial & Industrial has also been estimated for 2025 in urban strategy.

Table 9.4.2 Distribution of Required Land Area to LLGs in the Project Area

LLG	2025	2050
Lae	175 ha (D 110 ha ; CID 65 ha)	820 ha (D 510 ha ; CID 310 ha)
Urban		
Wampar	385 – 505 ha (D 325 – 445 ha ; CID 570 ha)	2,510 – 3,280 ha (D 940 – 2,710 ha ; CID 570 ha)
Rural		
Ahi	400 ha (D 265 ha ; CID 135 ha)	1,910 – 1,930 ha (D 1,580 – 1,600 ha ; CID 330ha)
Rural		
Nabak & Labuta	10 ha (D 10 ha ; CID 0 ha)	10 ha (D 10 ha ; CID 0 ha)
Rural		
Total	970 – 1,090 ha (D 710 – 830 ha ; CID 260 ha)	5,250 – 6,040 ha (D 4,040 – 4,830 ha ; CID 1,210 ha)

*D = Developed Area, CID = Commercial & Industrial

Development Area, Source: JICA Project Team

CHAPTER 10 BASIC URBAN DEVELOPMENT CONCEPTION

10.1 Strategic Development Scenarios

(1) Economic Development Scenario

As an economic driving force including logistic function to introduce foreign investors for economic development or to reinforce related industries is a future vision of Lae Nadzab Area. The foreign investor-led economy creates a large concern about sustainability of economic activities in the region. On the other hand, economic development by reinforcing related industries fosters import substitute industries and dominant industries for local market through human resource development.

In this Project the latter economic development is adopted. Human resource development including training of technicians and engineers, reinforcement of SME supporting measures, and infrastructure base for industrial development will be promoted.

Table 10.1.1 Comparison of Two Possible Scenarios and Impacts for Lae-Nadzab Area

	Economic development through foreign investors depending on the local resources for export and local market oriented industries	Economic development through related industry for fostering import substitutive industries through human resource development
Main player	Private	Government
Return	early return	considerable time required for harvesting
Sureness of harvesting	sure	sure depending on circumstances
Employment power	small	large
Technological accumulation possibility in the area	small	large
sustainability	small	large

Source: JICA Project Team

(2) Spatial Development Scenario

On the prerequisite of above economic development scenarios, three development patterns shown in the table below are compared.

Table 10.1.2 Comparison of Development Patterns

	Urban Development Pattern		
	Concentric pattern to Lae	Dual core pattern of Lae and Nadzab	Multi-core pattern of Lae, Nadzab and Yalu
Outline			

Source: JICA Project Team

Multi core urban development pattern was adopted after the comparison of three development patterns and sounding results of stakeholders' opinions. Firstly, it is important to give the legislative power to the urban development plan including land use plan for controlling the land use to achieve "Garden City." Secondly, ILG registration shall be promoted so that leasing right of customary land can be commodity at the land market to make it easy to develop. Key points for spatial development scenario are:

- How growth centers will be established,
- When and where urbanization for undeveloped customary land will be implemented, and

- What type of infrastructure for industrial development will be developed taking the opportunity of regional transport projects.

The area for new urbanization shall be identified by willingness of land users. Industrial park and urbanization shall be located near the regional transport facility like Lae Port, Nadzab Airport and Highlands Highway or along the roads that connect such regional facilities.



Figure 10.1.1 Lae-Nadzab Area Development Scenario

10.2 Industrial Development

10.2.1 Principle of Industrial Development and Selection of Promising Industry

Papua New Guinea Development Strategic Plan 2010–2030, Lae-District 5 Year Development Plan 2013–2017 (5year plan) and Lae-Nadzab Urban Development Plan 2005–2015 (10 year plan) are the three core principles to determine industry development of the target area.

Sustainable economic development of the country would not be realized without constructing robust industrial base; however, there are no magically medicinal agents for promoting industrial development at once. Expansion of employment market will be realized as a spin-off effect from the industrial development.

Promotion of promising industry by developing industrial agglomeration or industrial park would be realistic. The key to success of industrial parks is reflected by the kind of industry to be invited and installed. Therefore, we have to select candidates of promising industry carefully based on the condition of industrial framework as well as business climate.

(1) Road map to industrial development

Industrial structure of PNG in terms of variety of subsectors, number of enterprises, inter-enterprise cooperation system, economic infrastructure, skill training system, SME promotion measures and so on is so weak that ordinary growth as has been seen in fairly-developed industrial countries like Thailand, Indonesia, Malaysia cannot be expected. Therefore, a long-term development target of "PNG becoming an industrial nation in 2050" was set and then a road map for the target as shown in the following figure was stipulated.

10.2.2 Industrial Development

(1) Principle of industrial development

The principle of the industrial development plan is summarized as follows:

- Urge industry development by enhancing labor intensive industry to ease unemployment pressure of the youth.
- Nurture market competitive industry which can assure sustainable business operation.

(2) Overview of business climate to urge industrial development

The business climate of PNG by using SWOT analysis method was outlined. The following shows part of the SWOT result.

Strength: Political stability/ Abundant workforce/ Abundant agro products/ Rich marine resource

Weakness: Few expertise/ lack of industrial specialist/ Poor raw materials gathering system

Opportunity: Improvement of Highlands Highway/ Improvement of power transmission system

Threat: Harvest failure/ Political corruption/ Unclear public operation

10.2.3 Project to Develop Industry in Lae-Nadzab Region

Specialization and technical competitiveness of small manufacturers have been strengthened through a reciprocal system.

10.2.3.1 Concept of industrial development

- Construct industry agglomeration to accelerate growth of small manufacturing companies.
- Develop an industrial cluster to foster new food processing businesses as well as woodworking businesses.

10.3 Living Condition Development

10.3.1 Living Condition Development Concept

Several aspects are identified for improvement through the Project development plan for better livelihood of the local residents. The followings are the targets of development:

- House living improvement
- Local infrastructure improvement
- Employment and income opportunity improvement
- Educational system and service improvement
- Healthcare service improvement
- Other public service improvement

10.4 Urban Structure and Land Use

10.4.1 Restriction and Inducement by Laws and Regulations

(1) Restriction and inducement by Physical Planning Act and Regulation

“The Physical Planning Act” (1989) and “The Physical Planning Regulation 2007” (2007) are the acts concerning the land use restriction and inducement. Physical Planning Areas in the country automatically fall under the areas declared as Development Promotion Area which is capable of sustaining intensive development promotion activities. National/Provincial Physical Planning Board can divide Physical Planning Area into one or more zones under the “Physical Planning Act,” and this zoning system can be applicable to both state land and customary land.

Zoning is based on the purification of the land use for upgrading of urban environment or effectiveness of urban services. Monitoring of illegal development is carried out by Morobe Provincial Planning Board. In case where illegal land development occurs, Physical Planning Office of Division of Lands issues the order of construction suspension.

(2) Restriction and inducement by Building Act and Building Regulation

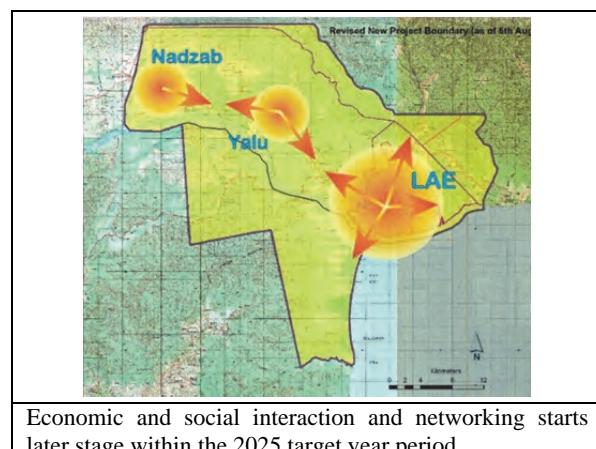
“Building Act” (1971) and “Building Regulation” (1994) exist for building standard and regulation. “Building Act” (1971) applies to all buildings in townships and to such buildings or such classes of buildings in prescribed areas as are declared by the Minister regardless of the zones designated by Physical Planning Act. Small

houses are not controlled by Building Act and Building Regulation. Building Act and Building Regulation are not sufficient for land use control, and zoning by Physical Planning Act is necessary to complement the land use control. Building Board monitors the illegal building activities.

10.4.2 Spatial Development Concept with Possible Effect to the Region

The following points are the major aspects that the region will benefit through the Urban Master Plan within the Project target year (until 2025). Land use will become more flexible, easy and properly controlled for effective industrial and economic development.

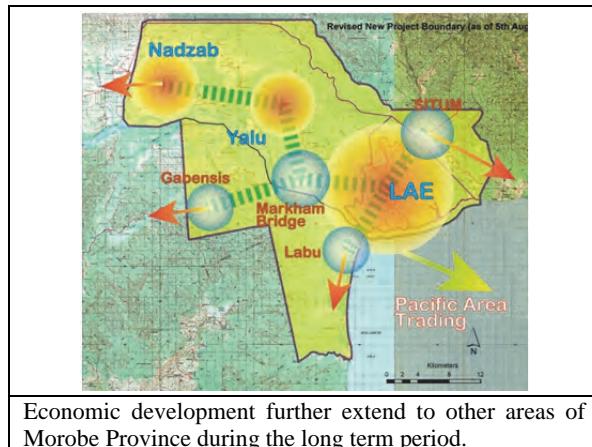
- Development in the region and utilizing urban spaces become more comprehensive.
- Small Medium Enterprises will be supported and strengthened through the economic development plans with healthier business and market environment.
- Increased job opportunities in the region will assist families in the region for more income.



Economic and social interaction and networking starts later stage within the 2025 target year period.

The following points are the expected changes through the Urban Master Plan after 2025 aiming long-term development by 2050:

- Intensified cooperative industrial activities in many sectors will change the marketing behavior with many new products utilizing the locally available resources.
- Isolated rural areas in the region will be physically connected and they will be in the same industrial and economic activities.
- The extension of economic activities will further stretch to the other regions for more development.

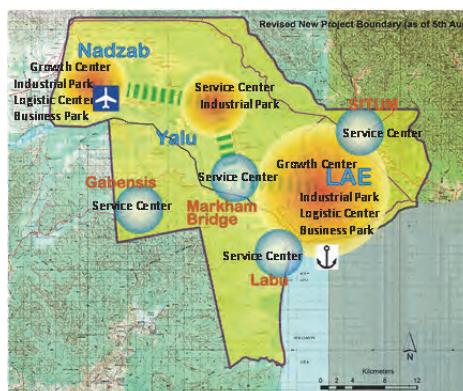


10.4.3 Basic Concept According to the Urban Structure

(1) Regional cooperation and development direction of Lae economic zone

The industrial development will be used as a tool or strategy to promote the real development. In "Papua New Guinea Development Strategic Plan 2010–2030" Lae-Nadzab Area is positioned as Urban Centre of Economic Corridor.

Lae-Nadzab Area has become a hub for overseas and domestic trade. According to the study, the following should be considered as fundamentals for urban structure of Lae-Nadzab Area: (i) focusing on connection of west region of Highlands and the major port and airport, (ii) Aiming for further development as an international industrial city, and (iii) considering an environmentally friendly for sustainable community development



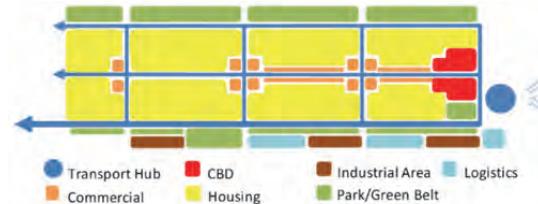
Source: JICA Project Team

Figure 10.4.1 Image of Functional Allocation of Industry

It is reasonable to allocate industrial promotion with the transport network expecting spin-off effect to the neighboring area. Tidal Basin area, Yalu area, Airport area and Malahang area are included.

(2) Formation of road network structure

Emphasizing on accessibility to Lae central area, the structure of road network which is necessary for the development and expansion of the city should be considered. In order to ensure the effectiveness of development by connecting bases of each area through multiple routes, Ladder Network can be proposed.

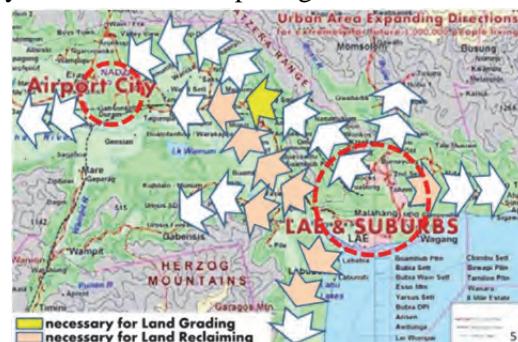


Source: LNUDP 2005-2015

Figure 10.4.2 Urban Development Ladder Pattern

(3) Development and expansion of urbanized area

The development and expansion will proceed in the vicinity of Lae City for the time being, and there is great possibility of proceeding into the Tidal Basin hinterland and the direction of Yalu-Igam Bypass especially. In the ultra-long term, it seems that the urbanized area will develop and expand based on two city cores, Lae City and Nadzab, interposing Yalu.



Source: JICA Project Team

Figure 10.4.3 Direction of Urbanization Promotion for Lae-Nadzab Area

10.4.4 Basic Concept of the Land Use

At the moment, the urbanized area in Lae City has expanded to the northeast direction from Lae Central, in the range of 10 to 15 km. In order to absorb population growth and to contribute to economic development, utilizing unused land is more realistic approach for the time being.

Introducing integral combination housing and workplace, and mixed land use is effective to the locations where the informal settlements are expanding, in order to provide the playing field and a mechanism to carry out the founding support of small- and medium-sized industry.

CHAPTER 11 URBAN DEVELOPMENT PLAN

11.1 Project Formulation

For the formation of development projects, development goals should be formulated with its level of achievement (indicator), so the level of goals will become good benchmark to evaluate the achievement of the urban development plan. The following are tentative value of development goals for the urban development master plan of Lae-Nadzab Area.

Table 11.1.1 Tentative Target Value of Development Goal

Level of Goals (tentative)	Tentative Target Value for Goal Achievement
Rate of parks and other parks in land use	40m ² /person
Rate of parks and open space in land use	15% of colored area in Physical Planning Area
Covering rate of public transportation	More than 70% for expected urbanization area
Level of traffic congestion	Less than 1.2
Average travel time	More than 30km/h
Level of transport route congestion for goods	Less than 1.0
Unemployment rate	Improve to unemployment rate of 5.0% from 8.9%
Rate of population who has easy access to urban centers	100%, Less than 1 hour
Rate of water supply/sewer service population	50%
Covering ratio of storm water drainage system	Protection level of 5 to 10 year probability for storm drain system
Covering ratio of waste management system	70%
Incident Rate of Flooding	Protection level and measure for 20 to 50 year probability for flooding.
Police station per population	One (1) station in every 1.5km radius catchment area in urban or mid-high populated area. One (1) station in every village or community with population over 1,000.
Change in average travel time	Less than 80% against future traffic with current road network and condition
Change in share of car use	More than 50% of modal split for public transport
City operation cost per capita	Operation & management costs of the city & region do not increase despite graded up operation and management

Source: JICA Project Team

11.2 Industrial Development Plans/Projects

11.2.1 Construct Industry Agglomeration to Accelerate Growth of Small Manufacturing Companies

- (1) Promotion of industrial agglomeration through reallocation of related industries to a designated area

It is proposed to promote the development of industrial clusters in three subsectors, woodwork/furniture, metalworking and food processing. Simultaneously, small business incubation project and efficient raw materials gathering system should be promoted.

It should be noted, however, that, in consideration of PNG's present technology levels, it is not realistic to expect that these industries and products can aim for export markets in the initial development stage. It is, therefore, recommended that they should first focus on a domestic market, while efforts will be made to improve international competitiveness so that they will be able to make inroads into foreign markets in the near future.

- 1) Promotion of industrial agglomeration relating to the repairing of metalworking products

The project should be positioned as a strategic initiative to foster small repair and metalworking shops, which will constitute the first step to foster the machining industry in the country. Concentration of metalworking companies in a designated area is expected to create synergy among them and then an overall ability to offer a wide range of metalworking services and products.

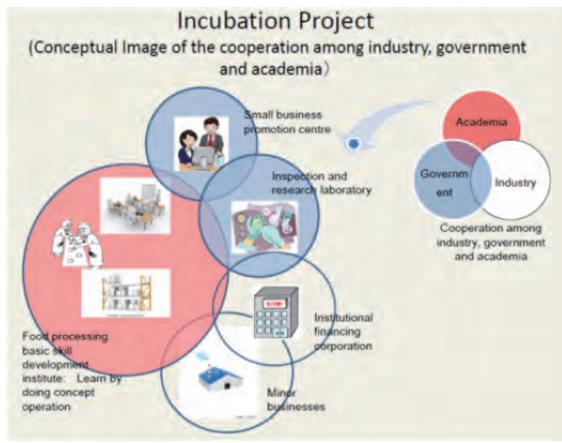
- 2) Project proposal for the woodworking industry development center (promotion of woodworking technology for the local industry)

It is proposed to foster woodworking companies capable of making furniture and woodwork products that meet the actual needs in PNG.

The project will focus on induced settlement of SMEs specialized in production of furniture, toys and other woodwork products, interior goods for local consumers in a designated area.

3) Project proposal for the food processing industry development center

It is recommended to set import substitution as the immediate goal, while placing export markets as the medium- and long-term goals. The key elements of project implementation are the “establishment of an effective materials collection system” and “close connection with the canning factory.”



Source: JICA Project Team

Figure 11.2.1 Image of Food Processing Focusing on Cannery

Small food processing companies will be arranged with the canning factory as the starting point for the food processing chain, together with infrastructure facilities designed for food production to form an industrial park that meets the needs of the industry.

(2) Industrial Vitalization Center (Agribusiness skill development)

This program aims at improving employment, business start-up, market access, and support for small and middle sized enterprises by technical training for food processing, food hygiene testing/inspection, and business promotion, which lead to creation of industrial cluster. The center consist of “food processing basic skill training center”, “small business development center”, “inspection and research laboratory”, “branch of institutional financing corporation” and private minor businesses.

(3) Agro Products Consolidation Depot

The delay of development of agro-products collection system and the organization of small-scale farmers causes obstacles of lowering consumer price and the growth of food processing industry in PNG. To tackle gathering system improvement and unionization of small

scale farmers is needed before starting food processing industry development.

Logistic center should be operated by a cooperative or a private company that has knowledge and experience and the center should deal with not only wholesale but also retailing to individual consumers. The main actors of logistic center are the cooperative, the management company, wholesaler and auction participants.

11.3 Living Condition Development Plan

11.3.1 Goals and Target Indictors of Social Service Development

According to the analysis discussed in Section 10.3, social service development plans are proposed in order to realize the concept for the region. Each plan should come up with development goal and targeted indicator of the development.

Table 11.3.1 Goals and Target Indicators of Social Service Development

Development	Goals	Target Index of Goals
Provide equal and quality educational opportunity to children	Ensure accessibility to each school	<ul style="list-style-type: none"> ➢ Catchment area radius of each school ➢ Travel distance and time
	Ensure quality of educational services provided to students	<ul style="list-style-type: none"> ➢ Ratio of teachers to students in each class ➢ Types of classroom provided
Provide better & appropriate opportunity with healthcare services	Ensure accessibility to each healthcare facility	<ul style="list-style-type: none"> ➢ Catchment area radius of each healthcare facility ➢ Travel distance and time
	Ensure quality of healthcare services provided to local people	<ul style="list-style-type: none"> ➢ Population ratio for each facility ➢ Number of healthcare workers and officers for each facility ➢ Number of ambulance provided
Improve local recreational opportunity and services	Ensure balanced distribution of public recreational services	<ul style="list-style-type: none"> ➢ Number of public parks ➢ Catchment area radius for each facility
	Create safe local public facilities	<ul style="list-style-type: none"> ➢ Level of security ➢ Number of security officials to attend
Improve local community services	Create accessible and effective community facilities	<ul style="list-style-type: none"> ➢ Catchment area radius for each facility ➢ Population ratio to facility area

Development	Goals	Target Index of Goals
Improve community or regional market opportunity	Create accessible and effective market	<ul style="list-style-type: none"> ➢ Catchment area radius for each market ➢ Travel distance and time
	Ensure security and safety of market	<ul style="list-style-type: none"> ➢ Level of security ➢ Number of security officials to attend
Improve security and safety of the region	Ensure security and safety level	<ul style="list-style-type: none"> ➢ Population ratio per police station ➢ Number of police officer per each station ➢ Catchment area radius per station

Source: JICA Project team

11.3.2 General Development Plans/Projects

According to the Project Area living condition analysis and effective contribution to the regional economic and social development, the following social services should be improved or expanded:

- Primary and Secondary Schools
- Healthcare Facilities (Aid Posts and Health Centers)
- Public Parks (Recreational and Sports)
- Police Stations
- Community Centers

11.4 Examination for Proposed Structure Plan

11.4.1 Basic Idea for Planning Proposed Structure Plan

Locations to realize the plans by 2025 is assumed to be limited extremely. Therefore, it is effective to achieve the resident induction near the project actively by undertaking the planned urban development projects proactively, for example, Yalu-Igam Bypass, industrial development of Tidal Basin hinterland, and fishing port development in Wagan, etc.

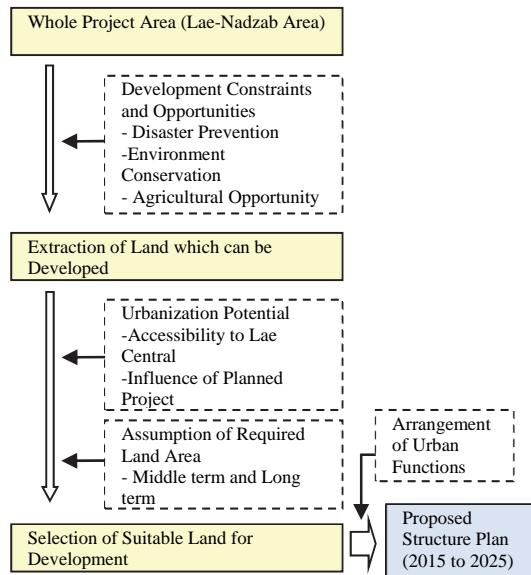
Also, securing project sites for short-term development and expansion, and for future development is essential to develop sustainably.

11.4.2 Overview of Urban Function Arrangement

(1) Urban Function Arrangement Examination

The following three places are considered as the bases that support Lae-Nadzab Area: i) Lae Central with international port and urban area

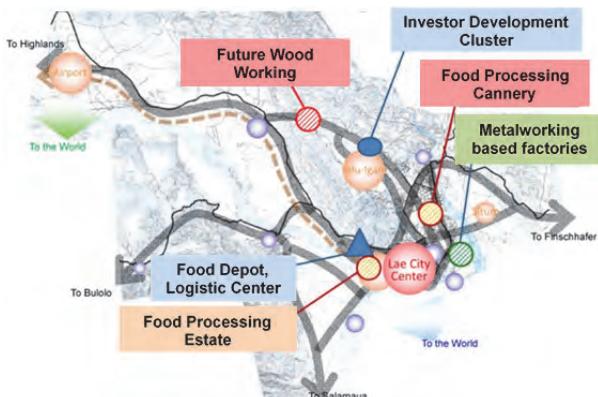
within Lae City, ii) Lae North where population integration is growing in Lae City, and iii) Nadzab with major airports with growth centers to support provincial level and regional level developments.



Source: JICA Project team

Figure 11.4.1 Examination Procedure of Proposed Structure Plan (2015 to 2025)

In Lae-Nadzab Area, urbanized area will develop as urban core around Yalu-Igam Bypass and Tidal Basin. The position of the growth center will be formed like ladder structure. It is desirable to locate the recreation function taking advantage of seaside natural resources in Tikeling, Wagang and Labu.

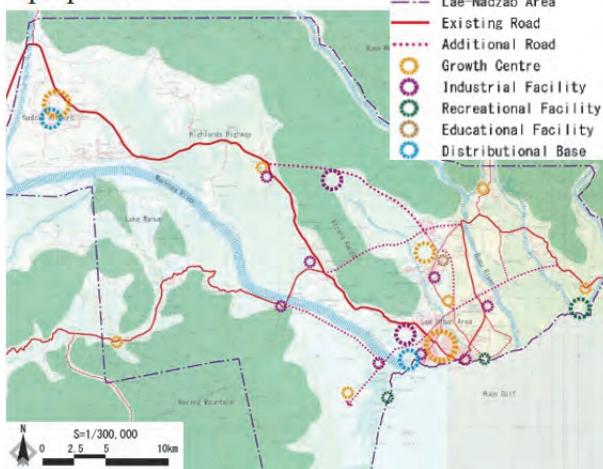


Source: JICA Project Team

Figure 11.4.2 Proposed Arrangement of Industrial Project

(2) Proposed arrangement of urban functions

The arrangement of urban functions such as commercial, business and community function (growth center), industry and recreation is proposed.



Source: JICA Project Team

Figure 11.4.3 Proposed Arrangement of Urban Functions for Lae-Nadzab Area

11.5 Preparation of Regulatory Structure Plan and Zoning Plan

11.5.1 Preparation of Proposed Structure Plan

(1) Future development plan towards creating Zoning Plan

Zoning Plan is based on the Physical Planning Act 1989 to limit the land use and building construction. Structure Plan is an expressive plan which proposes content of LNUDP to indicate the future regional policy and development. The Zoning Plan has effect of regulatory and induction, and the Structure Plan is intended as a base diagram for image sharing.

(2) Preparation of Proposed Structure Plan

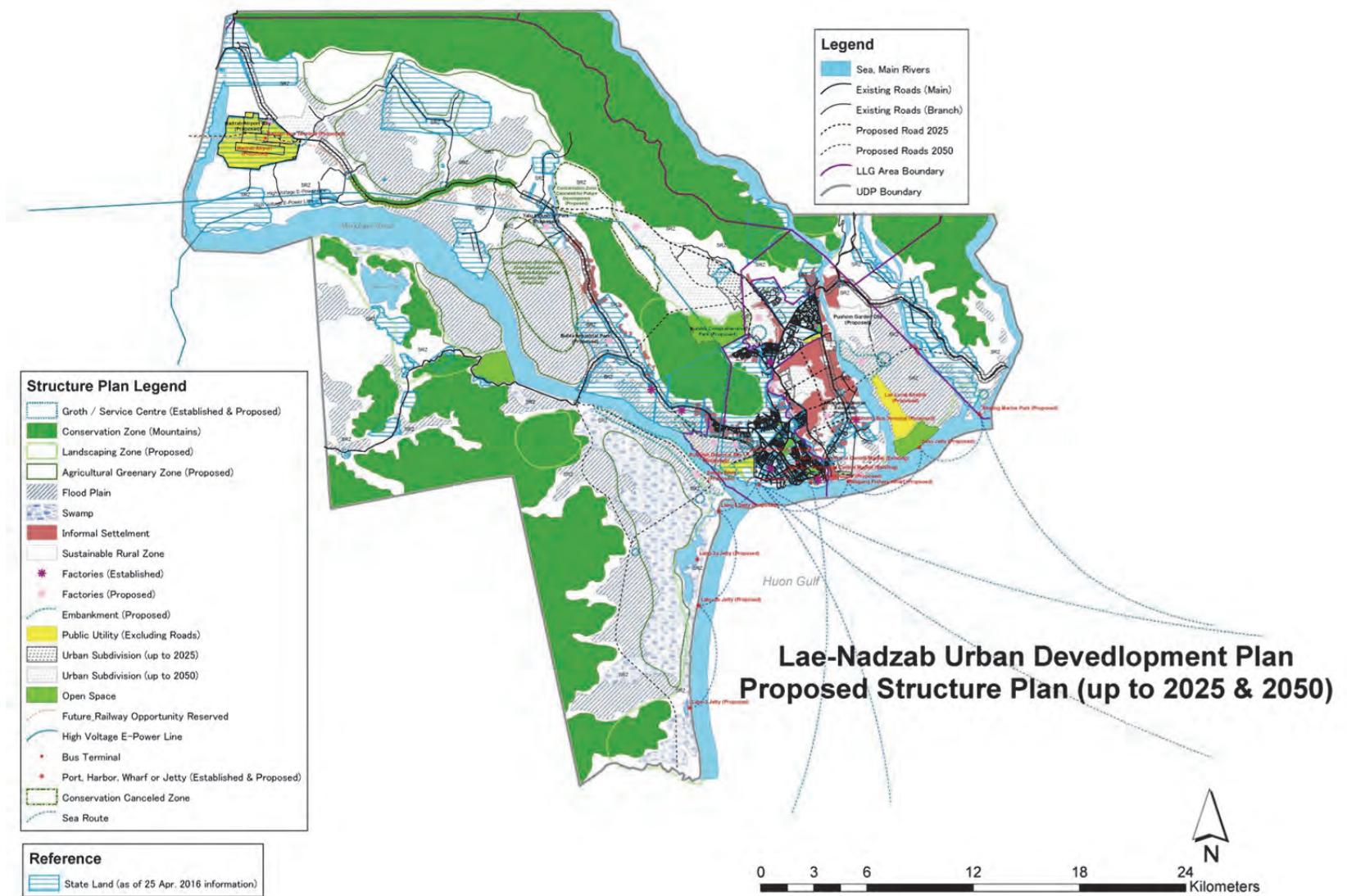
- 1) Urbanization aimed at Garden City
- 2) Promotion of agriculture
- 3) Development project for corresponding population increase & industrial development
- 4) Development of urban infrastructure facilities to support livelihood and industries

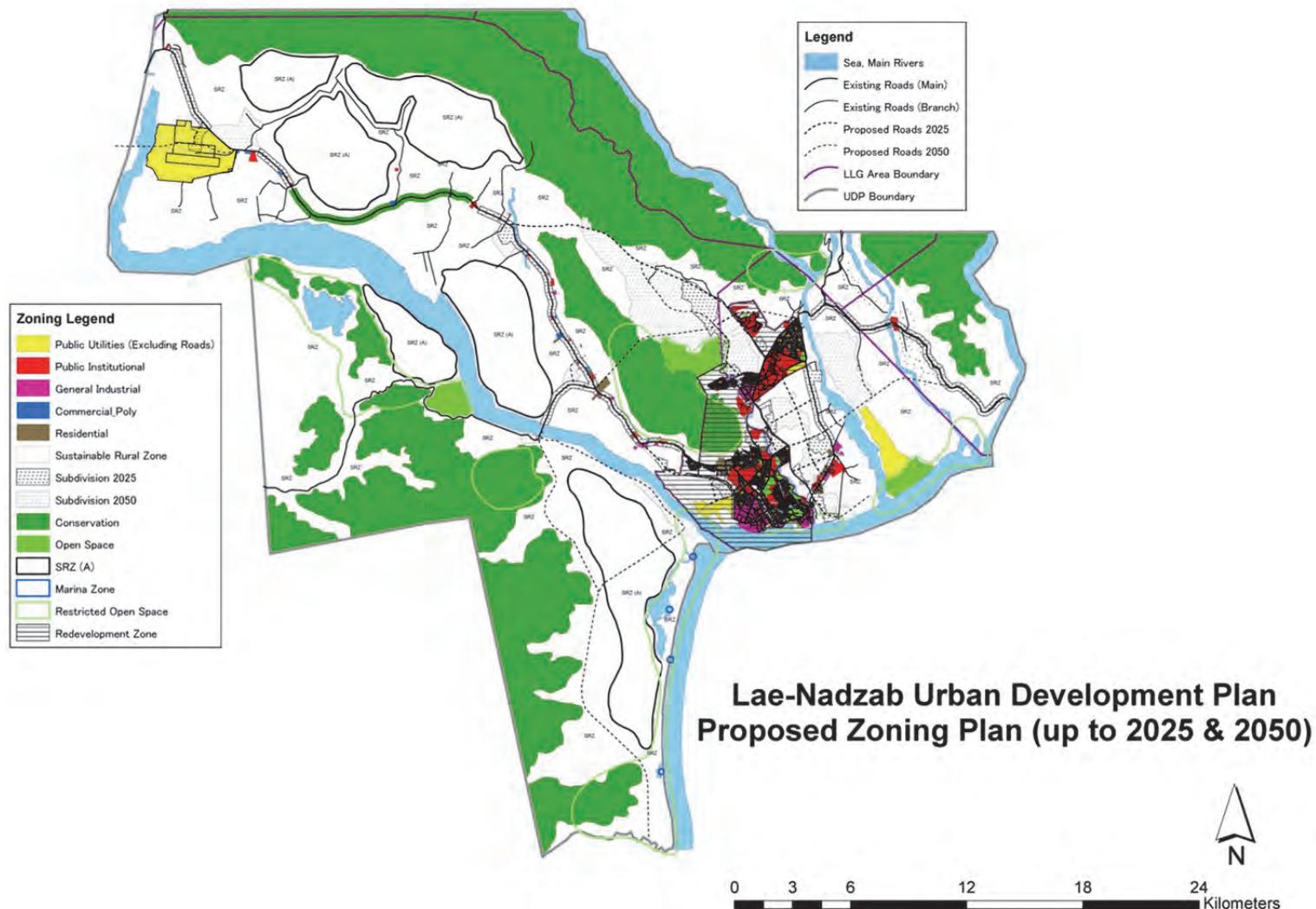
11.5.2 Preparation of Proposed Zoning Plan

(1) Planning regulations and guidelines in light of the Structure Plan

(2) Preparation of Proposed Zoning Plan

- 1) Emphasis on environmental protection and landscape formation
- 2) Built-up area to continue operating the existing system
- 3) Regulations and guidelines tailored to the characteristics of the development district
- 4) The pursuit of the possibility of setting a new zone





Source: JICA Project Team

Figure 11.5.2 Proposed Zoning Plan for Lae-Nadzab Area

11.6 Reference of Concept Image Plan for Future Development

11.6.1 Selection of the Project Site to be Prioritized

The candidate sites (21 sites) for future development projects are selected towards further examination of Proposed Structure Plan. It is important to share the image of the bases of the formation proposed earlier, and it also important that the Concept Image Plans are exemplified as reference of planning in the future.

11.6.2 Concept Image Plan for Future Development Project as Reference

(1) Projects for Lae Urban Area

- 1) Lae Provincial Growth Centre, Lae Old Airport [State Land]



Source: JICA Project Team

Figure 11.6.1 Concept Image Plan for Lae Provincial Growth Centre at Lae Old Airport

- 2) Buimo Garden Villa [State Land]
- 3) Igram Garden Villa [State Land]
- 4) Lae Port Tidal Basin North [State Land]

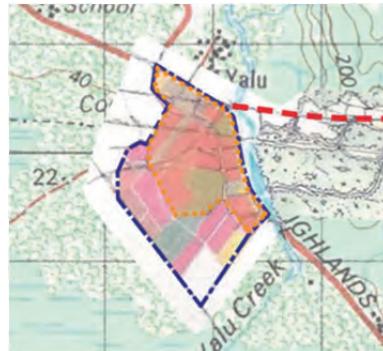


Source: JICA Project Team

Figure 11.6.2 Concept Image Plan for Lae Port Tidal Basin North

(2) Projects for Wampar Rural Area

- 1) Wampar Gate at 5-6 Miles [State Land]
- 2) Bubia Industrial Park [State Land]
- 3) Yalu Industrial Park [State Land]



Source: JICA Project Team

Figure 11.6.3 Concept Image Plan for Yalu Industrial Park

4) Nadzab Airport Science City [State Land and Customary Land]



Source: JICA Project Team

Figure 11.6.4 Concept Image Plan for Nadzab Airport Science City

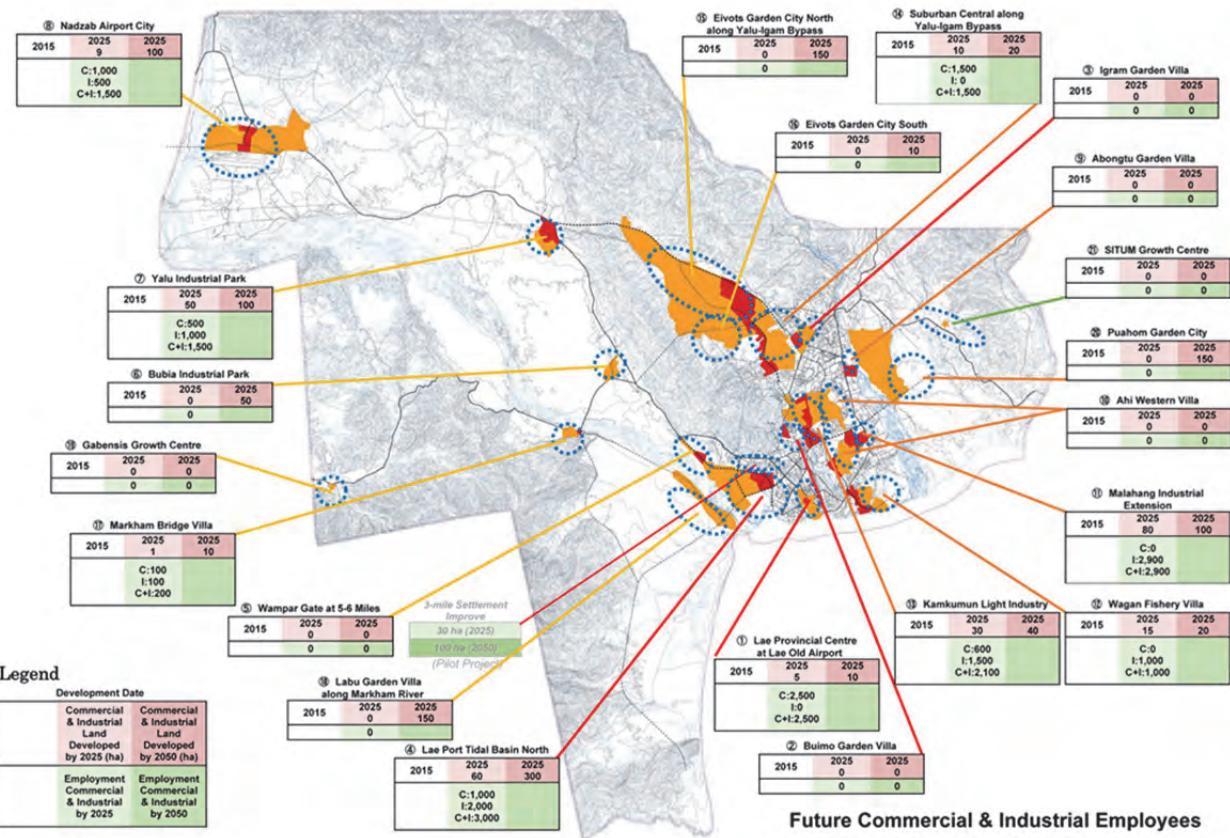
5) Eivots Garden City (North & South) [Customary Land]

- 6) Markham Bridge Villa [Customary Land]
- 7) Labu Garden Villa along Markham River [Customary Land]
- 8) Gabensis Growth Centre [Customary Land]

(3) Projects for Ahi Rural Area

- 1) Abongtu Garden Villa [Customary Land]
 - 2) Ahi Western Villa [Customary Land]
 - 3) Malahang Industrial Extension [Customary Land]
 - 4) Wagan Fishery Villa [Customary Land]
 - 5) Kamkumun Light Industry [Customary Land]
 - 6) Suburban Growth Center along Yalu-Igam Bypass [Customary Land]
 - 7) Puahom Garden City [Customary Land]
- 4) Project for Nabak Rural and Labuta Rural Areas

- 1) Situm Growth Centre [State Land]



Source: JICA Project Team

Figure 11.6.5 Distribution of Required Land Area for Commercial & Industrial Development to Respective Projects

CHAPTER 12 INFRASTRUCTURE AND SERVICES PLAN (Sectoral)

12.1 Land Transport

12.1.1 Travel Demand Forecasting

The travel analysis was based on the traditional four-step model. The data from the household survey, person trip survey, traffic count survey and roadside interview survey were the main inputs of the analysis. The main steps of the demand forecasting process with the main results are explained below.

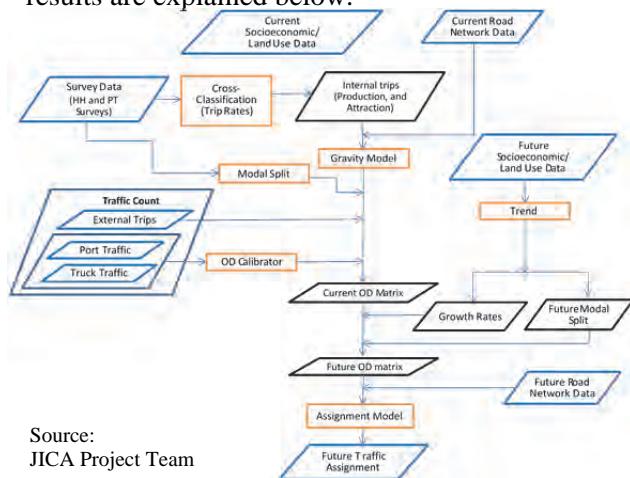


Figure 12.1.1 Traffic Demand Forecasting Process

(1) Trip Generation

Cross-classification (category analysis) method was used to estimate the trip production and trip attraction rates. After adjusting for the underreporting, the average daily trip rate obtained was 2 trips per person for both urban and rural areas.

(2) Trips Distribution

Gravity model was calibrated for the trip distribution, and then the estimated current and future internal trips were distributed based on the gravity model. The road side interview was used to distribute the external trips. The origin-destination matrix of the truck trips was estimated by OD Calibrator.

(3) Modal Split

The economic growth and subsequent motorization is expected to shift the current modal split. An extreme future scenario in which the PMV share shrinks from 75% to 40% and that of the car increases from 25% to 60% is considered. The current vehicle occupancies of 4.26 and 17.43 of cars and PMVs, respectively, are assumed to remain the same.

(4) Traffic Assignment

A base case, which shows the current traffic condition, and two future scenarios, a do-minimum case and a do-something case, were analyzed. In the do-minimum case, the network is assumed to remain as it is, except for the completion of the major works (Highlands Highway Widening Project) underway and maintenance works. In the do-something case, however, the network is modified to address future traffic as to be explained later.

In the current condition, the volume to capacity ratio (VCR) of the network is below one, except for few areas, such as Bumbu Bridge and Markham Bridge, however, major bottlenecks will appear in the future if the network remains as it is, as Figure 12.1.1 confirms.



Source: JICA Project Team

Figure 12.1.2 Do-minimum Case Traffic Assignment (2025)

12.1.2 Future Traffic and Network

The future road network may be developed from two directions mainly focused on relieving bottlenecks and improving the level of service.

(1) Relieving bottlenecks

One of the most compelling issues that should be addressed is the traffic flow crossing the Bumbu River, as the capacity of the two bridges will be by far lower than the expected traffic by 2025.

Moreover, two more bottlenecks are observed at the Markham Bridge and the Busu Bridge & their approaching sections which are currently one lane, although their traffic is relatively low. These sections are required to be expanded into two lanes. On the other hand, although basic road sections other than intersections have enough capacities, intersections are often congested. Under the estimated traffic volume in 2025, ten intersections in Lae City exceed their capacities as a roundabout, and therefore, they should be improved into signalized intersections.

(2) Improving level of service

Taking account of the existing major road network, topography, major cities, industrial hubs and proposed development areas, new major roads are identified in order to mainly improve the level of service.



Source: JICA Project Team

Figure 12.1.3 Future Transport Network

In parallel with above new road developments, rehabilitation/improvement of some part of the existing road network is required.

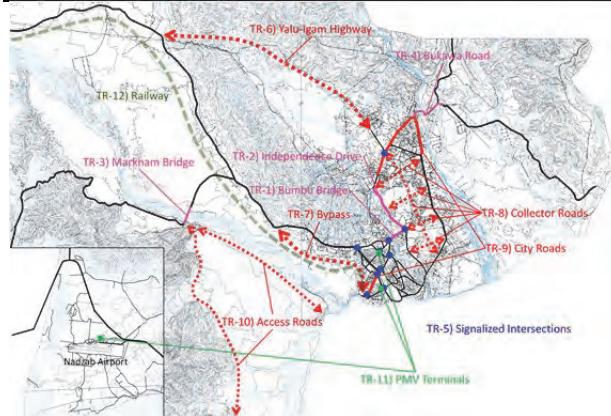
12.1.3 Public Transport Plan

Two of the three main PMV terminals located in the Main Market and Eriku do not have enough spaces for the operations and are causing traffic jams around them; therefore, their improvement are urgently required. However, it is difficult to improve unless the government introduces the proper control/management system of PMV and land for their expansion is not provided. There is also the demand for long distance freight and passenger transport between Highlands and Lae. From a long-term perspective, railway could be an alternative to the highway, but its feasibility has to be studied.

Table 12.1.1 Land Transport Projects

No	Project Title	Proposed Location
TR-1	Widening of North Bumbu Bridge and related roads	North Bumbu Bridge
TR-2	Widening of Independence Drive	Independence Drive
TR-3	Widening of Markham Bridge	Markham Bridge
TR-4	Widening of Bukawa Road	One lane section of Bukawa Road
TR-5	Signalization of intersections in Lae City	Lae City
TR-6	Construction of Yalu-Igam Highway	Area between Yalu and Igam
TR-7	Construction of Bypass Highway behind Lae Tidal Basin	Area behind Lae Tidal Basin and between Highlands Highway and Markham River

No	Project Title	Proposed Location
TR-8	Construction of collector roads between Independence Drive and Busu Road	Ahi Rural Kamkumun Area enclosed by Independence Drive, Busu Road and Telkom Road
TR-9	Rehabilitation of Lae City Roads	Lae City
TR-10	Rehabilitation of two access roads to Labu areas	Labu area
TR-11	Construction of PMV Terminals	Main Market area, Eriku area and Airport City
TR-12	Feasibility Study for Railway between Highland area and Lae Port	Between Lae and Mount Hagen
TR-13	Technical Assistance for PMV Management	—
TR-14	Technical Assistance for Road Maintenance	—



Source: JICA Project Team

Figure 12.1.4 Location of Land Transport Projects

12.2 Maritime Transport

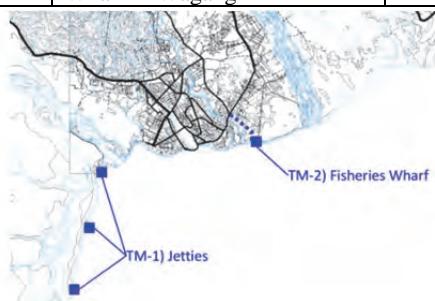
12.2.1 Maritime Transport Plan

As explained in Chapter 6.2.1, a major maritime cargo transport was planned by PNG Ports Corporation and the expansion of Lae Port is on-going under the support of ADB.

Taking account of existing conditions, the following two projects are proposed.

Table 12.2.1 Maritime Transport Projects

No	Project Title	Proposed Location
TM-1	Construction of Jetties for Labu	Labu area
TM-2	Development of Fisheries Wharf in Wagang	Wagang area



Source: JICA Project Team

Figure 12.2.5 Location of Maritime Transport Projects

12.3 Air Transport

12.3.1 Air Transport Plan

As explained in Chapter 6.3, the air transport improvement has been planned by JICA with National Airport Corporation and the Nadzab Airport rehabilitation project is on-going under Japanese ODA Loan.

12.4 Water Supply

12.4.1 Target Sites and Area for Water Supply Development

Of the long list of candidate project sites, 22 sites are in areas designated as land use zones under the Lae-Nadzab Urban Development Plan. Therefore, the candidate project sites for the water supply development sites under the Project are basically set in the aforementioned 22 areas.

12.4.2 Urban Development Plan of Target Sites for Water Supply

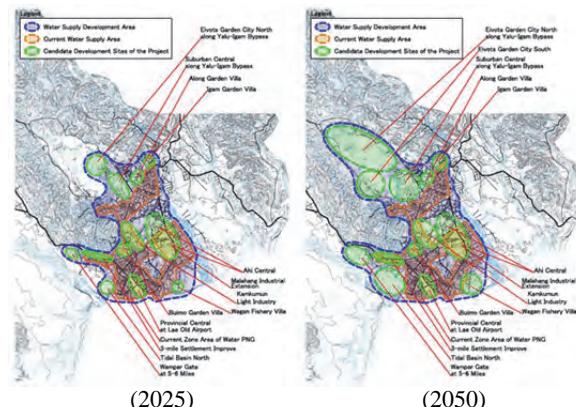
From the development plan of this Project, the current (2015) and projected (2025, 2050) populations of each target site are calculated. And also, from the development plan of land use, water supply facilities for 2025 and 2050 are considered.

12.4.3 Master Plan of Water Supply

(1) Water Supply Development in Lae

1) Target Area

Target area of Water Supply Development in Lae (2025, 2050) is set as below according to the land development plan of this Project.



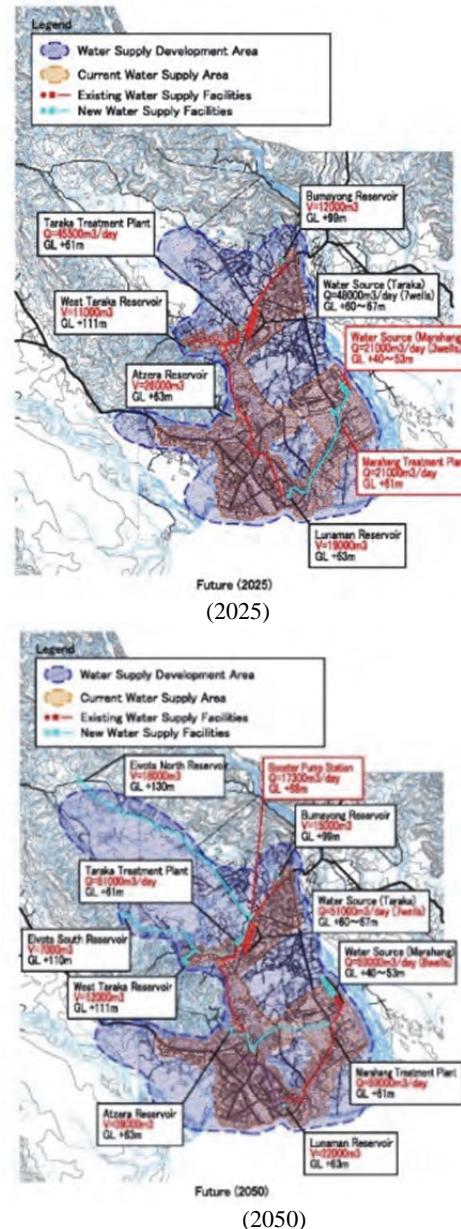
Source: JICA Project Team

Figure 12.4.1 Water Supply Area for the Future (2025, 2050)

2) Water Supply Facility Plan

Presently, water supply facilities of Lae City

consist of seven boreholes (East Taraka, along the gravel road in front of UNITEC), one treatment plant (East Taraka, 2 x 1500 m³ storage tanks, ten pressure pumps), four reservoirs (Bumayong, West Taraka, Lunaman, Atzera), trunk mains and distribution mains.



Source: JICA Project Team

Figure 12.4.1 Future Plan (2025, 2050)
Excluding Distribution Main

As a basic concept, this Master Plan redevelops the simple flow of water for easily managing water supply facilities.

Trunk mains are laid not only from the Taraka treatment plant, but also laid from Bumayong reservoir. In addition, almost all trunk mains are connected with distribution mains; therefore,

the water from the Taraka treatment plant is consumed before getting to the reservoirs. Thus, Lunaman reservoir is not filled with water. Furthermore, the trunk main from Bumayong reservoir is higher than Atzera and Lunaman reservoir, and is connected with the distribution main. Therefore, especially at Atzera reservoir, the water from the distribution main flows back to Atzera reservoir, and Water PNG disconnected Atzera reservoir from the distribution main.

To address this situation, this Master Plan considers making all trunk mains completely separate from distribution mains and only connected to the treatment plant.

(2) Other Target Area for Water Supply Development

1) Population Projection of Target Sites

From the development plan of this Project, current (2015) and projected (2025, 2050) populations of each target site are calculated. And also, from the development plan of land use, water supply facilities for 2025 and 2050 are considered.

2) Water Demand

The specifications of major water supply facilities (water source, trunk main, purification plant, reservoir, etc.) are planned and designed based on the peak daily flow (PDF).

In this Project, water source considered is a borehole with a submersible pump, and every target site will have a chlorine sterilization system. The volumes of reservoirs are considered as outlined in the PDF, and the reservoirs are planned to be constructed on the highest point of each target area.

12.5 Sanitation and Sewerage

12.5.1 Development Concept and Planning Frame

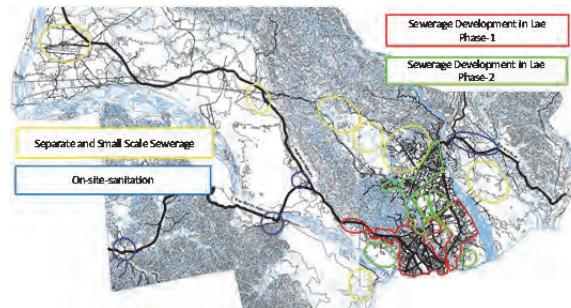
In principle, in the area to be covered by piped water supply, either sewerage or septic tank system should be extended as shown in Table 12.5.1. On the other hand, the remaining areas, where the piped water supply are not planned, are to be managed by the traditional on-site-sanitation. Nevertheless, improved sanitation should be promoted for the on-site-sanitation. Figure 12.5.1 is a conceptual location map for systems to be introduced by this master plan.

According to the National Water Supply and Sewerage Act, Water PNG should be in charge of development, operation and maintenance of sewerage system. On-site-sanitation, however, should be provided and managed by the citizens on a self-help basis.

Table 12.5.1 Concept for Wastewater Management System

Condition		System to be Taken
Piped water supply area	Populated and near a sewage treatment plant to be constructed in Lae.	Sewerage system to be extended in Lae Urban and Ahi Rural.
	Populated but far from a sewage treatment plant to be constructed in Lae (Remote cities).	Small sewerage system to be separated from the system of Lae Urban and Ahi Rural.
	Not populated and remote cities.	On-site-sanitation, mainly septic tank to be adaptable to flush toilet.
Non piped water supply area		On-site-sanitation (improved sanitation should be promoted.).

Source: JICA Project Team



Source: JICA Project Team

Figure 12.5.1 Cities to Develop Sewerage

12.5.2 Sewerage Development in Lae (Existing Water Supply Area and Surroundings)

(1) Development Phases

The area, presently covered by water supply, should be prioritized for sewerage development. It should include the present water supply areas in Ahi Rural. Accordingly, phasing development is recommended as shown in Table 12.5.2.

Table 12.5.2 Phasing for Sewerage Development in Lae

Phase	Target Year	Covering Area
Phase-1	2025	<ul style="list-style-type: none"> - Presently covered by water supply and surroundings, and - Presently <u>covered</u> by trunk sewers and surroundings, but - Excluding Unitech and East Taraka
Phase-2	Later than 2025 and by 2050	<ul style="list-style-type: none"> - Unitech and East Taraka and surroundings, and - Presently covered by water supply and surroundings, but - Presently <u>not-covered</u> by trunk sewers.

Source: JICA Project Team

(2) Required Capacity and Sewage Treatment Plant

The forecasted service population is 103

thousand (2025) and 226 thousand (2050). To cover the population, the sewerage system should be developed as shown in Table 12.5.3.

Table 12.5.3 Options for Sewage Treatment Process

Phase	Service Population	Treatment Capacity	Area of Sewer Networks
Phase-1	103,059 (2025)	41,000m ³ /d	2,633ha
Phase-2	225,992 (2050)	add 41,000m ³ /d	add 2,447ha
		to be 82,000m ³ /d	to be 5,080ha

Source: JICA Project Team

As for the sewage treatment plant, Oxidation Ditch is recommended. Proposed site is in Tidal Basin North as shown in Figure 12.5.2.



Source: JICA Project Team on Google Earth Image

Figure 12.5.2 Location of Planned Site for Sewage Treatment Plant in Lae (1)

12.5.3 Sewerage Development for Remote Areas

For remote areas, wastewater management should be separately undertaken by area according to the wastewater flow. Small scale sewerage is recommended for the remote cities having 1,000 m³/d of wastewater flow or more. Oxidation ditch is also recommended for the treatment process. Necessary capacity is summarized in Table 12.5.4.

Table 12.5.4 Planning Conditions and Recommended Systems for Remote Areas

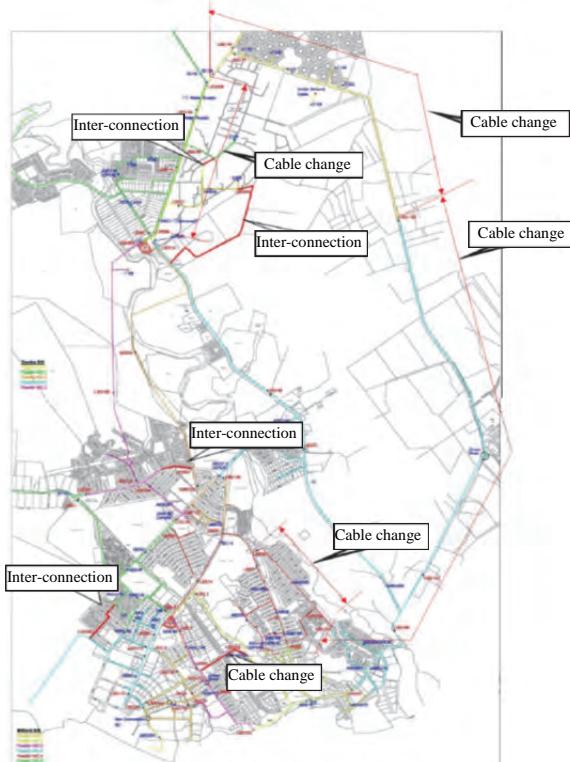
Area	Planned Population in Target Area		On-site-sanitatio n (m ³ /d)		by Sewerage				
	2025	2050	PH1	PH2	PH1	PH2	PH1	PH2	
					Flow (m ³ /d)	STP Capacity (m ³ /d)	Sewer Area (ha)	PH1	PH2
Suburban Central along Yalu-Igam Bypass, incl. Igam Garden Villa, Abong Gardeia, Banda	7,251	20,251			1,459	4,311	1,500	4,600	140 540
Banda Garden Center North along Yalu-Igam Bypass	17,000	91,000			2,839	17,285	3,000	19,000	230 1050
Banda Garden Center South	0	37,000				6,833		7,000	700
SITUM	6,557	21,769	22	22					
Puan Garden City	9,000	30,000				6,877		7,000	800
Bubia Industrial Park	4,664	6,219			938				
Yalu Industrial	4,692	7,005				1,900	3,738	1,900 3,800	90 150
Nadzab Airport City	4,000	22,000				1,414	9,339	1,900 9,500	120 900
Makham Bridge	1,840	3,944	274	814					
Gabensis	1,937	3,100	270	452					
Labi Tourism Village along Makham River	1,734	10,890	438			5,762		6,000	250
	58,718	253,178	1,270	2,223	7,612	54,145	8,300	55,800	560 4,390

Source: JICA Project Team

12.6 Power Supply

The description of Power Supply Plan in this Report is an excerpt from “Lae Area Distribution Network Improvement Plan (Draft)”.

12.6.1 Short-Term Distribution Network Improvement Plan



Source: JICA Project Team

Figure 12.6.1 Short-Term Distribution Network Improvement

Importance short-term focus is the reduction of blackout duration. Installation of sequential switching system is promoted for enabling earlier re-charge of other segments of the feeder during accident recovery work.

12.6.2 Long-Term Distribution Network Improvement Plan

The area will be divided into blocks and electricity supply routes from substation will be prepared as a Long-Term Distribution Network Improvement Plan up to 2030.

(1) Electricity Demand Forecast

Total electricity demand in Lae area in 2030 is estimated at 115 MW.

Table 12.6.1 Electricity Demand Estimate in Lae Area

Demand	Year	2015	2020	2025	2030
	Milford	21	32	46	61
Taraka	19	29	42	54	

Load (MW)(A)	Nadzab	0.3	0.3	3	10
Total		40.3	61.3	91	125

(2) Power Supply System

Hides power source line is connected to Dobel substation by a 275kV dual-circuit transmission line, and Dobel and Walium substations are connected by a 132kV dual-circuit line. Dobel and Ramu1 substations are connected by a 132kV one circuit transmission line.



Note: Blue line: 275kV transmission lie
Red line: 132kV transmission line
Black line: Existing 66kV transmission line

Figure 12.6.2 Power Supply System Construction by 2030

(3) Electricity Supply Block Plan

Covering area of electricity supply by 2030 is shown below.



Figure 12.6.3 Covering Areas of Electricity Supply by Substation (2030)



Figure 12.6.4 Covering Areas of Electricity Supply by Substation (2015)

Note: In the Plan, Labu area, Eviot area along proposed Yalu-Igam Highway are not covered

by those substations. For land use project implementation, revision of the electricity supply block plan will be necessary.

12.7 Communication Infrastructure

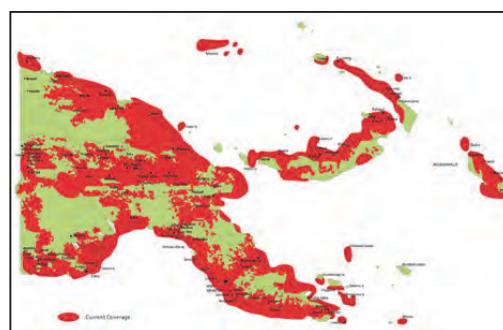
12.7.1 Communication Infrastructure Development Strategies

The long-term communication development strategy of Papua New Guinea is outlined in the Papua New Guinea Vision 2050. The target of the Vision 2050 is to increase the communication access to 100% of the population. The strategies proposed by the PNGDSP 2010–2030 to achieve the stated goals are as follows:

- Carrying out phase 2 reforms of ICT policy with competitive services
- Utilizing PPP to provide services in order to achieve the PNGDSP targets by 2030
- Maintaining relationships with international ICT organizations
- Ensuring compliance with international conventions, and standards
- Expanding government services to rural communities with mobile and internet technologies.

12.7.2 Communication Infrastructure Development Plans

The PNGDSP 2010–2030 target is to increase the number of mobile subscribers and to increase the internet access which was just 2.3% in 2010 to 70% by 2030. The media coverage (radio and television) also will increase to 100%.



Source: Digicel PNG

Figure 12.7.1 Digicel Current Coverage

12.8 Solid Waste Management

12.8.1 Development Policy

The sector vision of solid waste management is “Creating a Recycling Society and Sanitary Environment, and Realizing Eco-friendly Industrial Development through 3Rs (reduce,

reuse and recycling) Activities". The 3R activities are important factors to create a recycling society. By harnessing wastes as materials, life time of materials is extended. This activity has already been applied to a lot of countries and led to great success in terms of natural and social environment. The sector vision can be achieved by conducting basic policies as follows.

Basic Policy

1. Formulating broad-based by-law for solid waste management in the project area
2. Promoting 3Rs activities
3. Rehabilitation of existing dumpsite and construction of sanitary landfill
4. Efficient use of resources in industry
5. Capacity development in waste management sector

12.8.2 Development Plan

Strategy

- 1) Establishment of associated laws, policies and regulations
- 2) Promotion of 3R activities
- 3) Rehabilitation of existing dumpsite and construction of sanitary landfills
- 4) Cooperation with stakeholders on reduction of organic waste
- 5) Capacity development for waste management sector of local level governments

1) Establishment of Associated Laws, Policies and Regulations

a) By-laws on Solid Waste Management in Project Area

It is proposed to establish broad-based by-laws on solid waste management applied to the Project Area.

b) Policies and Regulations to Promote 3R Activities

The establishment of policies and regulations for recycling activities will encourage the recovery and recycling market to be promoted and developed faster.

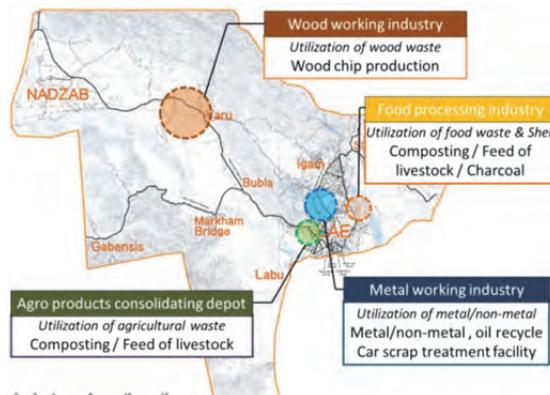
2) Promotion of 3R Activities

a) Practice of 3R Activities in the Existing Recovery and Recycling Market

Preferable way for promoting 3Rs may be to make the best use of the existing recovery and recycling routes provided by private firms.

b) Practice of 3R Activities in Projected Industrial Parks

Industrial development projects would generate several kinds of industrial wastes which include recyclable materials. Since each project has specific characteristic in terms of type of recyclables, separate strategies for 3R activities should be proposed according to each project type as shown in the figure below.



Source: JICA Project Team

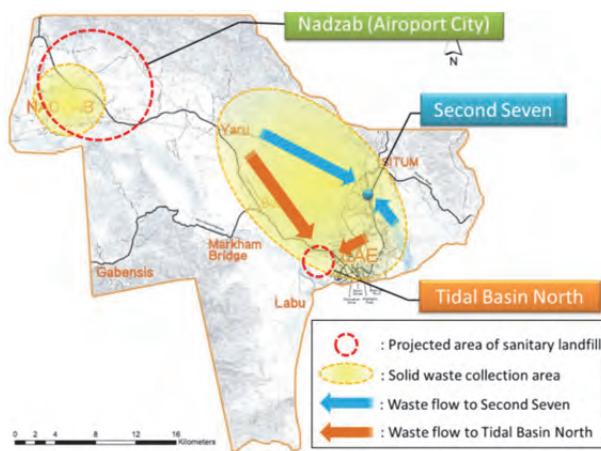
Figure 12.8.1 Map of Material Utilization

3) Rehabilitation of Existing Dumpsite and Construction of Sanitary Landfills

Semi-aerobic sanitary landfill system (Fukuoka Method) can be established with lower cost and lower technology compared with the other landfill methods.

Roughly half of the Second Seven Dumpsite area could be used to construct a dump site with sanitary landfill of 2.5 ha and a leachate pond of 0.5 ha.

Additional landfills should be constructed for retaining solid waste after 2025 as shown in the figure and table below.



Source: JICA Project Team

Figure 12.8.2 Image of Waste Collection Area and Waste Flow

Table 12.8.1 Final Disposal Site by Year 2050

Period	2016-2019	2020-2028	2029-2039	2040-2046	2047-2050
Lae Urban Area					
Open dumping site	Second Seven	-	-	-	-
Sanitary landfill	-	Second Seven* (2.5 ha)	North of Tidal basin (Cell-I) (5 ha)	North of Tidal basin (Cell-II) (5 ha)	North of Tidal basin (Cell-III) (5 ha)
Period	2016-2024		2025-2045		2046-2050
Nadzab Airport Area					
Sanitary landfill	-	Nadzab Airport City (Cell-I) (0.5 ha)	Nadzab Airport City (Cell-II) (0.5 ha)		

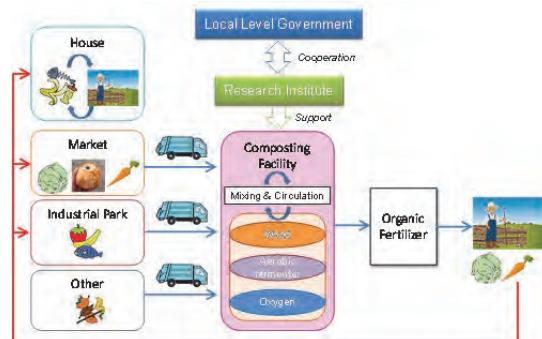
* Waste pickers segregate recyclables

Source: JICA Project Team

On the other hand, financial assistance, which is required for operation and maintenance of landfill sites and vehicles, employment cost, etc., shall be fairly allocated to local level governments from national government

4) Cooperation with Stakeholders on Reduce Action of Organic Waste

A pilot project of composting organic waste should be conducted to identify the best way to produce high quality compost with low cost. The composting business should be operated by private firms in the future.



Source: JICA Project Team

Figure 12.8.3 Image of Organic Waste Recycling Loop

5) Capacity Development for Waste Management Sector of Local Level Governments

The expansion of administrative jurisdiction of LULLG is proposed in order to manage and implement the items proposed in this sectoral master plan.

The collection and transportation services should be continuously outsourced to contractors for appropriate price. Firstly, the current conditions of the services should be analyzed by implementing "Time and Motion Study".

Besides, it is indispensable for waste management administration to understand the current situation of solid waste composition and solid waste amount to be transported to final the disposal site.

12.9 Disaster Management and Storm Water Drainage

12.9.1 Disaster Management

PNG has suffered from the natural disasters, such as volcanic activity, earthquake, storm, landslide and so forth. As already mentioned, the government of PNG has been tackling these problems.

12.9.2 Storm Water Drainage Management Plan

The procedure of the Storm Water Drainage in the Project Area is shown below.

(1) Calculation Conditions

- i) A 10-year probable rainfall is adopted for the calculation of the discharge of drainages in the development districts and classified as follows:

- 10-year probable rainfall of Bubia : for all

- Development Districts except the Nadzab Development District
- 10-year probable rainfall of Nadzab : for the Nadzab Development District
- ii) Rational equation is used for the calculation of the discharge of drainages.

(2) Calculation Result

The calculation result is shown in Table 12.9.1.

Table 12.9.1 Calculation Result for the Drainage with 10-year Probable Rainfall

		10yrs		Nadzab	
t ₁ (min.)	L(m)	v(m/s)	t ₂ (min.)	T(min.)	C
1	7	224	1.76	2.12	9.1
2			1.80	2.08	9.1
3			1.85	2.01	9.0
4			1.94	1.92	8.9
5			2.00	1.87	8.9
6			2.03	1.84	8.8
7			2.13	1.75	8.8
8			2.18	1.71	8.7
9			2.27	1.65	8.6
10			2.31	1.61	8.6
11			2.44	1.53	8.5
		10yrs		Bubia	
t ₁ (min.)	L(m)	v(m/s)	t ₂ (min.)	T(min.)	C
1	7	224	1.76	2.12	9.1
2			1.80	2.08	9.1
3			1.85	2.01	9.0
4			1.94	1.92	8.9
5			2.00	1.87	8.9
6			2.03	1.84	8.8
7			2.13	1.75	8.8
8			2.18	1.71	8.7
9			2.27	1.65	8.6
10			2.31	1.61	8.6
11			2.44	1.53	8.5

Source: JICA Project Team

(3) Quantity for Candidate Projects

Table 12.9.2 Concrete Quantity per Meter Length of the Drainage

District	Concrete quantity per meter (m ³ /m)
Nadzab Development District	0.58
Development Districts except the Nadzab Development District	0.71

Source: JICA Project Team

(4) Scales of Storm Water Drainage Projects

Preliminary scales of river improvement projects are shown in the Table 12.9.3

Table 12.9.3 Preliminary Scales of River Storm Water Drainage Projects

No.	Project Title	Location	Implementing Agency	Concrete Volume (m ³)
I-1	Metal working industry development center	Kamkumun	MPA/ICDC	1,271.8
I-2	Wood working industry development center	Yalu industrial park	MPA/ICDC	318.0
I-3	Industrial vitalization cluster			
I-4	Agro products consolidating depot	Tidal basin	MPA	476.9
I-5	Food processing industry	Malahang industrial area	ICDC	159.0

No.	Project Title	Location	Implementing Agency	Concrete Volume (m ³)
	development center based on setting up of empty-can manufacturing company			
L-1	Tidal Basin North Development	Lae Port North Zone (composite type) (Including Javani Industrial Park)	IPBC (Indep. Pub. Busi. Corp)	19,077.1
				9,061.6
L-2	Yalu Industrial Park Development	Yalu (composite type) Growth Center: MPA	Industrial area Planned by MoI (ICDC)	4,769.3
				3,179.5
L-3	Wagan Fishery Park Development	Wagan Industrial Zone Development (excluding port construction)	Planned by FA	635.9
				8,902.7
L-4	Airport City Development	Nearby area of Nadzab Airport (composite type)	MPA	23,452.8
				2,605.9
L-5	Ahi Rural (KamKunun Area) Settlement Expansion for 30,000	Ahi Rural KamKunun	MPA	9,538.6
				1,589.8
L-6	Mahkham Bridge Road Side Service Center Development	Markham Point (composite type)	Commercial	318.0
				2,861.6
L-7	Provincial Center Development at Lae Old Airport	Lae Old Airport area (composite type)	Community Service Center by MPA	318.0
				9,538.6
L-8	New Urban Area Development at SITUM	Situm area (composite type)	Community Service Center by MPA	4,769.3
				318.0
L-9	Labu Tourism Village Development	Labu area (I + II) Especially Labu-I (composite type)	Tourist Service Center by MPA	4,133.4
				318.0
L-10	Kamkumun Industrial Area Development (composite type)	Kamkumun area	MPA	13,354.0
				36,564.5
L-11	Gabensis Service Center Development	Gabensis area Community Center (composite type)	MPA	9,856.6
				318.0
L-12	Suburban Central Development along Yalu-Igam Bypass	Neighboring area of Lae City (Development by community Pilot Project)	Initial Fund by MPA, Dev. Action by Community	3,179.5
				6,200.0
L-13	Eivots Garden Center North Development along Yalu-Igam		MPA	
L-14	Eivots G.C. South Development		MPA	
L-15	3-mile Settlement Improvement		MPA	
L-16	Malahang Industrial		MPA	

No.	Project Title	Location	Implementing Agency	Concrete Volume (m ³)
	Park			
L-17	Puahom Garden City Development		MPA	62,000.7
L-18	Bubia Industrial Park Development		MPA	3,815.9
L-19	Wampar Gate Development	Housing	MPA	3,179.5

Source: JICA Project Team

12.9.3 Flood Management Plan

(1) Current Situation of Rivers and the Need for River Management

In Papua New Guinea, rivers have not been utilized effectively for both flood control and water utilization purposes, and consequently they have not been managed either. Therefore, the river management is required in order to avoid this kind of situation. The objectives of the river management are summarized as follows:

- Prevention of damages during floods and high water (Flood Management)
- Utilization of rivers properly (Water Utilization)
- Maintenance of the normal functions of running water (Flood Management & Water Utilization)
- Improvement and protection of river environment (Environmental Protection)

(2) Countermeasures in Each River

The countermeasures for the flood control are considered for the rivers with insufficient flow capacity for the 50-year return period flow.

1) The Markham River

< The lower reaches of the Markham River >
The quantities of excavation for 1,000 m long levee and riverbed are about 330,000 m³ and about 3,510,000 m³, respectively.

< The right bank site of the Markham Bridge on the Markham River >

There are no major facilities in the vicinity of the Markham Bridge and the planned development site is limited to 1–2 ha. Moreover, there is a possibility for the Markham Bridge to be replaced. Therefore, raising development site level by about 3 m (soil volume: 60,000 m³) is determined to be economic. In the future, if this area would be developed in large scale, and it seems to be necessary to take measures such as embankments.

< The upper reaches of the Markham River >
There are not any major facilities and any

planned development district in the upper reaches of the Markham River. Therefore, the countermeasure is not considered in this area.

2) The Erap River

< The vicinity of Nadzab Airport in the Erap River >

The quantity of 3,400 m long riverbed excavation is about 3,630,000 m³.

3) The Bumbu River

< The lower reaches of the Bumbu River >

The quantity of 5,000 m long riverbed excavation is about 1,300,000 m³.

Since river improvement in the downstream has to be conducted before the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.

< The upper reaches of the Bumbu River >

The quantity of 7,500 m long riverbed excavation is about 1,370,000 m³.

4) The Busu River (except for the upstream portion)

< The lower reaches of the Busu River >

The quantity of 12,000 m long riverbed excavation is about 32,650,000 m³.

(3) Scales of River Improvement Projects

Preliminary scales of river improvement projects are shown in the Table 12.9.4

Table 12.9.4 Preliminary Scales of River Improvement Projects

No.	Project Title	Location	Scale	Quantity (m ³)	Cost (PGK)
WD-1	River Improvement in the lower reaches of the Markham River	The lower reaches of the Markham River	50-year return period	Embankment: 330,000 m ³ Excavation: 3,510,000 m ³	PGK 215.6 million
WD-2	Ground Raising at the right site of the Markham Bridge in the Markham River	The right site of the Markham Bridge	50-year return period	Excavation: 60,000 m ³	PGK 5.6 million
WD-3	River Improvement of the Erap River	The vicinity of Nadzab Airport	50-year return period	Excavation: 3,630,000 m ³	PGK 191.3 million
WD-4	River Improvement of the lower reaches of the Bumbu River	The lower reaches of the Bumbu River	50-year return period	Excavation: 1,300,000 m ³	PGK 68.5 million
WD-5	River Improvement of the upper reaches of the Bumbu River	The upper reaches of the Bumbu River	50-year return period	Excavation: 1,370,000 m ³	PGK 72.2 million

WD-6	River Improvement of the lower reaches of the Busu River	The lower reaches of the Busu River	50-year return period	Excavation: 32,650,000 m ³	PGK 1,720.2 million
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Source: JICA Project Team

12.9.4 Comprehensive Flood Control Measures

Levee construction and riverbed excavation require a very large amount of cost and time; therefore, it is difficult to achieve the goal in the short term. Moreover, along with the urbanization development, it becomes more difficult to prevent flood damage with just one countermeasure, such as the levee. Comprehensive flood control measures are very effective in this situation.

Since the river management has not been conducted up to now in PNG, a river management agency should be established as soon as possible, and the human resources development should be started. Since rainfall data and water level data are the indispensable data for flood control planning, it is necessary to improve the hydrological observation network.

12.10 Social Services

The general development plan of each facility type which is based on the socio-economic analysis, particularly population forecast in each ward, is discussed below.

(1) School Development Plan

1) Primary Schools

The enrollment of primary schools in the Project Area is still low and it is expected to increase significantly in the future. Therefore, the primary school development is the most urgent task to improve educational services in the Project Area.

Table 12.10.1 Estimates of Required Classrooms in Primary Schools in Labuta Rural LLG (2025)

LLG Name	Ward No.	Ward Name	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built
Labuta (L)	12	MUSOM/TALE	10.1	0	12
	13	SITUM	29.7	22	8

Source: JICA Project Team

Table 12.10.2 Estimates of Required Classrooms in Primary Schools in Nabak Rural LLG (2025)

LLG Name	Ward No.	Ward Name	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built
Nabak (N)	13	HOBU	5.3	0	6

Source: JICA Project Team

Table 12.10.3 Estimates of Required Classrooms in Primary Schools in Lae Urban LLG (2025)

LLG Name	Ward No.	Ward Name	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built
Lae Urban (LU)	1	ERIKU/BUNDI	137.1	55	82
	1	ERIKU/BUNDI			
	1	ERIKU/BUNDI			
	1	ERIKU/BUNDI			
	1	ERIKU/BUNDI			
	1	ERIKU/BUNDI			
	2	TOP TOWN	58.1	68	No Increase
	2	TOP TOWN			
	2	TOP TOWN			
	2	TOP TOWN			
	3	MAIN MARKET	57.1	30	28
	3	MAIN MARKET			
	3	MAIN MARKET			
	3	MAIN MARKET			
	4	HAIKOST	62.7	57	6
	4	HAIKOST			
	5	UNITECH	74.0	50	24
	5	UNITECH			
	6A	EAST TARAKA	21.4	23	No Increase
	6B	WEST TARAKA	33.9	30	6
	6C	IGAM	19.1	12	8

Source: JICA Project Team

Table 12.10.4 Estimates of Required Classrooms in Primary Schools in Ahi Rural LLG (2025)

LLG Name	Ward No.	Ward Name	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built
Ahi (A)	1	HENGALI	20.4	0	21
	2	BUTIBAM WEST	10.3	0	12
	3	BUTIBAM EAST	8.4	0	10
	4	WEST BUKO	3.0	0	3
	5	EAST BUKO	6.0	0	6
	6	WEST WAGANG	No Increase	N/A	No Increase
	7	EAST WAGANG	19.7	0	20
	8	YANGA	32.6	16	18
	8	YANGA			
	9	GAWANG	26.2	30	No Increase
	10	BUSURUM	6.1	0	6
	11	MALAHANG	2.6	0	3
	12	BUSU-POASA NG	22.3	0	24
	13	POAHOM	40.5	0	42
	14	LIMKI	64.5	0	66
	15	KAMKUMUNG	13.0	0	13
	16	POASUM	84.4	0	84
	17	BUMAYONG	45.0	6	40
	17	BUMAYONG			
	17	BUMAYONG			
	17	BUMAYONG			

Source: JICA Project Team

Table 12.10.5 Estimates of Required Classrooms in Primary Schools in Wampar Rural LLG (2025)

LLG Name	Ward No.	Ward Name	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built
Wampar (W)	3	GABENSIS	8.7	12	No Increase
	4	UMSIS	5.5	0	6
	5	MARKHAM BRIDGE	8.3	0	10

Source: JICA Project Team

Table 12.10.3 Estimates of Required Classrooms in Primary Schools in Lae Urban LLG (2025)

LLG Name	Ward No.	Ward Name	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built
	6	LABUTALE	No Increase	6	No Increase
	7	LABUMITI	5.7	6	No Increase
	8	LABUBUTU	7.8	6	2
	9	GAWANG/ 5 MILE	49.1	0	50
	10	ST JOSEPH	46.3	0	48
	11	AWILLUNGA	49.8	0	50
	12	BUBIA	30.5	30	No Increase
	13	BUSANIM	26.8	0	30
	14	YALU	21.1	12	9
	15	MUNUM	12.7	8	5
	16	NASUAPUM	6.7	8	No Increase
	17	GAPSONGKEG	37.3	12	26
	18	NAROMANGKI	7.7	2	6

Source: JICA Project Team

Based on the school data provided by the district administrations, the current number of classrooms of each school is adopted to calculate the required number of new classrooms in each ward.

Universal Basic Education Plan 2010–2019 of PNG (UBE Plan) suggests 35 to 37 students per classroom. However, the average number of students is set as 40 for each classroom for the next ten years, since less student density requires more rooms thus more teachers.

One primary school should be provided in 3 miles (about 5 km maximum, but 4 km maximum is more recommendable) in less populated rural areas for the target year, 2025.

2) Secondary Schools

Improvement of the existing secondary school facilities should be the priority, including accessibility improvement by maybe applying school bus system or more affordable boarding system and services for both male and female students with comfort and security. New secondary school development, however, should be considered where more population growth is expected.

3) Vocational Schools and Technical Colleges

The followings have to be developed for industrial promotions.

- Technical College in Nadzab Airport City
- Vocational schools nearby industrial development areas
- Technical College with UNITEC Program

(2) Healthcare Facilities

Most of the existing facilities are overburdened and they are expected to serve extremely large area and beyond their capacity; as a result, the radius of service (in other words, patients' walking or access distance) is very long. The regional healthcare service should be well developed with effective improvement to handle such population.

Table 12.10.6 List of Healthcare Facility Development in each Ward

LLG Name	Ward No.	Ward Name	Facility Development
Lae Urban (LU)	1	ERIKU/BUNDI	1. Upgrade of Kamkumum AP to CHP and reopen 2. Upgrade of Buimo CIS AP to CHP 3. New setup of one (1) CHP
	1	ERIKU/BUNDI	
	2	TOP TOWN	1. Angau Hospital to be upgraded by Australian Aid 2. Service improvement of Haikost UC
	2	TOP TOWN	
	2	TOP TOWN	
	2	TOP TOWN	
	3	MAIN MARKET	1. Upgrade of Milfordhaven UC to CHP 2. One (1) new Aid Post setup
	3	MAIN MARKET	
	3	MAIN MARKET	
	3	MAIN MARKET	
	4	HAIKOST	1. Upgrade of Buimo UC to CHP 2. One (1) new Aid Post setup
	4	HAIKOST	
	5	UNITECH	1. Upgrade of UNITEC UC to CHP 2. Upgrade of Tent City UC to CHP
	5	UNITECH	
	6A	EAST TARAKA	1. Share Buimo CIS CHP
	6B	WEST TARAKA	1. Upgrade of Taraka UC to CHP
	6C	IGAM	1. Service improvement of Igam UC
Ahi (A)	1	HENGALI	1. Service improvement of Butimum UC
	2	BUTIBAM WEST	1. One (1) new Aid Post setup
	3	BUTIBAM EAST	1. Service improvement of Ampo AP
	4	WEST BUKO	1. Share East Buko Aid Post
	5	EAST BUKO	1. One (1) new Aid Post setup
	6	WEST WAGANG	N/A
	7	EAST WAGANG	1. One (1) new Aid Post setup
	8	YANGA	1. New setup of one (1) CHP
	8	YANGA	
	9	GAWANG	1. One (1) new Aid Post setup
	10	BUSURUM	1. One (1) new Aid Post setup
	11	MALAHANG	1. Service and facility improvement of Halahang HC
	12	BUSU-POASANG	1. One (1) new Aid Post setup
	13	POAHOM	1. New setup of one (1) CHP
	14	LIMKI	1. New setup of one (1) CHP
	15	KAMKUMUNG	1. Share Kamkumum CHP
	16	POASUM	1. New setup of one (1) CHP 2. Share Malahang HC
	17	BUMAYONG	1. New setup of one (1) CHP
Labuta (L)	12	MUSOM/TALE	1. One (1) new Aid Post setup
	13	SITUM	1. Upgrade of SITUM HC to

LLG Name	Ward No.	Ward Name	Facility Development
			CHP
Nabak (N) Wampar (W)	13	HOBU	1. One (1) new Aid Post setup
	3	GABENSIS	1. Service improvement of Gabensis AP
	4	UMSIS	1. One (1) new Aid Post setup
	5	MARKHAM BRIDGE	1. Service Improvement of Markham Bridge AP
	6	LABUTALE	1. One (1) new Aid Post setup
	7	LABUMITI	1. Service improvement of Labumiti AP
	8	LABUBUTU	1. Service improvement of Labubutu AP
	9	GAWANG/5 MILE	1. Upgrade of 6-Mile AP to CHP
	10	ST JOSEPH	1. New setup of one (1) CHP
	11	AWILLUNGA	1. New setup of one (1) CHP
	12	BUBIA	1. Service improvement of Bubia AP
	13	BUSANIM	1. One (1) new Aid Post setup
	14	YALU	1. Service improvement of Muya AP
	15	MUNUM	1. One (1) new Aid Post setup
	16	NASUAPUM	1. Service improvement of Nasuapum AP
	17	GAPSONGKEG	1. Upgrade of Wampar HC facility and service with CHP function 1. Service improvement of Gabsongkek AP
	18	NAROMANGKI	1. Service improvement of Erap Station AP

Source: JICA Project Team

Many clinics or health centers in the Project Area have to serve extremely large catchment population and beyond their actual capacity and service level; many aid posts also face similar situation. These heavily loaded population ratios of each facility should be reduced for easier and better quality services, and more localized aid posts should be developed in the next ten years.

Under the PNG Community Health Post Policy 2013 (CHP Policy), a new concept and development can be brought to the community level healthcare system. This will provide more immediate service within the geographical boundary with at least three health workers providing wider range of primary healthcare.

This new system focuses on more localized primary referral to provide minimum but immediate care so that this facility development will be more effective for the next ten years. Facilities with catchment population of over 6,000 will be upgraded with CHP for better services.

Each CHP should act as the service operation center which controls other aid posts in the same development area.

Urban clinics (UC) and health centers (HC) are in a more serious situation. One (1) CHP

facility will be proposed for catchment area with over 10,000 population, and the existing UC or HC facilities will be upgraded or service will be improved including the service level and function of CHP.

(3) Public Parks

1) Recreational facilities and amenities

Current development of public parks in the Project Area indicates that rural areas have not been well treated or provided with public recreational facilities. More local community oriented parks should be provided for immediate use of the community residents. Large scale parks, such as regional parks or comprehensive parks, might be over scaled for the region within the target year. However, considering mid- to long-term developments under the national development plan such large scale park development may be necessary.

Public park development for the next ten years in the region should focus on the locally oriented small scale public park space development, which may be similar to the district parks (approx. 4 ha of open park within about 1 km walking distance for community residents) for local communities. Where a village is remotely located from other populated areas and has 500 to 1,000 households, it should be also provided with a public park but the size could be smaller.

2) Greening or green landscaping

With industrial park development and expansion, greening/green landscaping i) along inner roads, ii) in buffer zones, and up to 15% of the areas of industrial parks has to be encouraged.

3) Natural parks

There are coasts, lakes and lagoon in the Project Area. These natural resources can be utilized for touristic and recreational purposes while preservation of them have to be promoted. Existing Botanical Garden can be more open to the citizens. Development and expansion of local parks and public recreational and amenity facilities are planned.

4) Sports facilities

Though there are many sports facilities in Lae City, few of them are developed in sub-urban or rural areas. With the progress of the urban development, sports facilities have to be constructed in these areas.

(4) Community Centers

The existing community centers or similar facilities in the Project Area in general are not up to the expected quality in terms of sizes and functions for necessary community services except a few facilities.

It is necessary to provide community centers and facilities at a ward level in order to centralize ward level communication and activities among neighboring villages and communities. Traditions, culture and customs have to be considered in the development of the community facilities.

(5) Police Stations

Current PNG living environment is under major threat of criminal activities. However, the number of police stations and police officers allocated are not sufficient to protect citizens.

Reinforcement of daily police service is mandatory for healthy and strong economic development in the region. Thus, upgrading security service as well as expanding police service in the Project Area is necessary.

One police station will be developed for every 10 km² catchment area or for every community with population of 1,000 in rural areas. Each police station should be staffed with minimum three (3) police officers to effectively patrol the community.

12.11 Others

There are several possibilities to develop other service facilities for tourism activities. During the next ten years the Project may focus on the infrastructure development in the Project Area to improve wider accessibility. Meanwhile, more domestic tourists may come to visit regional tourism sites. For attracting foreign tourists, more efforts are necessary to provide high quality accommodation, reliable transportation system and network, safety and security, quality food, hygiene control, etc. Possible candidate sites may be selected in the Labu Coastal area and Wanum Lake area.

- Coastal area maritime resort development with existing lagoons and natural tropical forests to attract tourists.
- Eco-tourism utilizing natural mountain resources for trekking and wild animal watch, etc.

The followings have to be implemented:

- Existing natural conditions should be examined.

- Overall regional transportation network including the airport service should be upgraded and improved.
- Stable and reliable water and power supply should be installed.
- Local community based O&M bodies should be established.
- Park user guide and manuals as well as environmental control regulations should be well prepared.

CHAPTER 13 MASTER INVESTMENT COST AND FINANCE PLAN

13.1 Cost Estimate

In estimating the project costs of the MP, the structure of cost components is set as presented in Table 13.1.1. Based on this, the sector-wise project costs are estimated by referring to the following data and information:

- Other ODA project reports in PNG
- The actual contract cost provided by such organizations as Department of Works of National Government, Works & Transport Section and Health Section of Morobe Province Administration, and PNG Water.
- Price of bridge structures in Japan because of lack of such data.

Table 13.1.1 Project Cost Components

No	Item	Ratio	Formula
A	Construction Cost		
B	Engineering Cost	10%	A x 10%
C	Administration Cost	5%	A x 5%
D	Subtotal		A + B + C
E	Contingencies	10%	D x 10%
F	Subtotal		D + E
G	Tax (GST)	10%	(F-C) x 10%
Project Cost	Total		F+G

Source: JICA Project Team

13.2 Source of Fund

This chapter studies the source of fund in two steps: firstly, the financial capability of the governments for the MP based on their budgets; secondly, the expected financial sources to fill the gap between the capability and the investment costs of the MP.

(1) Budget of Central and Local Governments

1) Central Government

The government budgeted PGK 4,270 million for the capital expenditures in 2015, which is equivalent to 17% of the overall expenditure budget. Meanwhile, around 30% of the capital expenditures are to be funded by the international donors. Accordingly, the allocation from own revenue sources is estimated at PGK 3,000 million.

2) Provincial Government

The capital expenditure budget totaled PGK 176 million in 2015. This figure may have

included PGK 123 million from the Central Government; so the capital budget from the Provincial Government source is estimated at PKG 53 million in 2015.

3) Local Government

The size of capital budget is quite small, PGK 12.5 million in 2015 including the District Government and the Lae Urban LLG

(2) Funding to fill the Gap

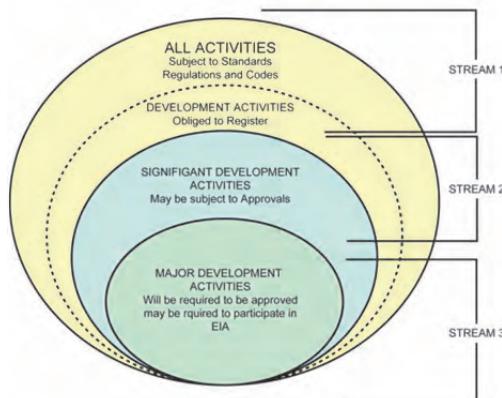
The MP costs shall be borne by the PNG government in principle. However, the financial capability of each government described in Chapter 15 obviously indicates that overall investment costs of the MP exceed the financial capability of the PNG government side. To fulfil the whole implementation of the MP, other sources of fund should be procured to fill up the gap; for this, the following measures are suggested:

- Requesting financial assistance from donors, especially for road construction, flood mitigation/control, and social sectors such as education and health
- Promoting the private sector participation, particularly in development of residential areas and industrial park
- Providing government guarantees to the revenue generating projects for bank loan and bond issue, especially for water supply and sewerage system
- Creating special subsidies for environmental protection, especially for solid waste management

CHAPTER 14 SOCIAL ENVIRONMENTAL ASSESSMENT

14.1 Legal and Administrative Framework

The Environment Act 2000, and the Conservation Environment Protection Authority (CEPA) which administers it, governs the legal framework for regulating the environmental effects of any project development. The Environmental Act 2000 is supported by the Environment (Prescribed Activities) Regulation 2002.



Source: Policy Making and Implementation: Studies from Papua New Guinea, Chapter10

Figure 14.1.1 PNG's Different Regulatory Streams

The Environment Act 2000 requires any development of a Level 2 and Level 3 activities to acquire an environment permit from the CEPA. The approval process is represented in Figure 14.3.1 below.

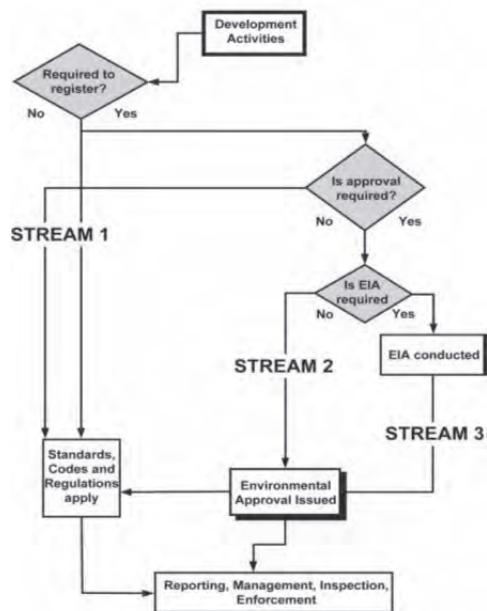
14.2 International Obligations

It is worth noting that international treaties can only be effective nationally if there is an enacted enabling legislation specific to the treaties, agreement, conventions and protocols that PNG is signatory to. It should be stressed that several of the bilateral and multilateral financing institution have developed stringent performance standards and guidance notes to which project funding recipients and contractors are required to comply with, such as IFC, JICA, WB, ADB, and Equator Principles are a few notable ones, where there are inadequacies in PNG Law.

14.3 JICA Requirements for Environmental and Social Guidelines

The JICA Guidelines for Environmental and Social Consideration of April 2010 provides the performance principles that guide undertaking of

Environmental and Social Considerations in ODA project development. According to the JICA guideline, the following seven principles that have to be met:



Source: Policy Making and Implementation: Studies from Papua New Guinea, Chapter10

Figure 14.3.1 PNG's Environment Regulatory Framework under Environment Act

- A “wide range” of impact must be assessed
- Measures related to Environmental and Social Considerations must be implemented “from an early stage through to the monitoring stage”
- JICA is responsible for “accountability” when implementing cooperation projects
- JICA asks “stakeholders” for their participation
- JICA “discloses information”
- JICA enhances “organizational capacity”
- JICA makes serious attempts at “promptness”

14.4 Positive and Negative Impacts Ratings of the Proposed Projects

Table 14.4.1–Table 14.4.4 below show the evaluation results.

14.5 Strategic Environmental Assessment

Stakeholder engagement was an integrated component of the project, and the activities to be undertaken were duly scheduled as an inherent part of the Project implementation schedule which began in June 2015 and continued for one year. The engagement activities have largely focused on informing and educating stakeholders about the project; Proactively catering for stakeholder issues and concerns; Providing opportunities for stakeholder input

into potential project identification and planning process.

**Table 14.4.1 Rating of Predicted Impacts
(Industrial Development & Land Use)**

IMPACTS	Overall Ratings									
	Industrial Development					Land Use				
	ID - 1	ID - 2	ID - 3	ID - 4	ID - 5	ID - 1	ID - 2	ID - 3	ID - 4	ID - 5
Social Environment	E	E	E	E	E	E	C	C	C	E
Local Economy	D	D	D	D	D	D	D	D	D	D
Employment, Livelihood	D	D	D	D	D	D	D	D	D	D
Land use, Utilization of Local Community	C	C	C	C	C	C	C	C	C	C
Existing Social Infrastructure & services	C	C	C	C	C	C	C	C	C	C
The poor, indigenous, and Ethnic People	E	E	E	E	E	C	C	C	C	E
Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C
Cultural heritage	C	C	C	C	C	C	C	C	C	C
Local Conflict of Interest	C	C	C	C	C	C	C	C	C	C
Water Usage & Sanitation	E	E	E	E	E	E	E	E	E	E
Sanitation	E	E	E	E	E	E	E	E	E	E
Accident	C	C	C	C	C	C	C	C	C	C
Infectious Diseases such as HIV AIDS	C	C	C	C	C	C	C	C	C	C
Natural Environment	E	E	E	E	E	E	E	E	E	E
Geographical Feature	E	E	E	E	E	E	E	E	E	E
Soil Erosion	E	E	E	E	E	E	E	E	E	E
Ground Water	C	C	C	C	C	C	C	C	C	C
Coastal Zone	E	E	E	E	E	E	E	E	E	E
Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E
Meteorology	C	C	C	C	C	C	C	C	C	C
Landscape	E	E	E	E	E	E	E	E	E	E
Global Warming	C	C	C	C	C	C	C	C	C	C
Pollution	E	E	E	E	E	E	E	E	E	E
Air pollution	C	C	C	C	C	C	C	C	C	C
Water Pollution	C	C	C	C	C	C	C	C	C	C
Solid Waste	B	B	B	B	B	B	B	B	B	B
Noise and Vibration	C	C	C	C	C	C	C	C	C	C
Ground Subsidence	E	E	E	E	E	E	E	E	E	E
Offensive Odour	B	B	B	B	B	B	C	E	C	C
Bottom Sediment	E	E	E	E	E	E	E	E	E	E

Source: Prepared by JICA Project Team

Source: JICA Project Team

**Table 14.4.2 Rating of Predicted Impacts
(Road Transport & Storm Drainage)**

IMPACTS	Overall Ratings									
	Road Transport					Storm Drainage				
	RT - 1	RT - 2	RT - 3	RT - 4	RT - 5	RT - 6	RT - 7	RT - 8	RT - 9	RT - 10
Social Environment	B	B	C	C	C	E	E	E	E	E
Local Economy	D	D	D	D	D	D	D	D	D	D
Employment, Livelihood	D	D	D	D	D	D	D	D	D	D
Land use, Utilization of Local Community	D	B	C	C	C	C	C	C	C	C
Existing Social Infrastructure & services	D	C	C	C	C	C	C	C	C	C
The poor, indigenous, and Ethnic People	E	B	E	E	C	E	E	E	E	E
Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C
Cultural heritage	E	E	E	E	E	E	E	E	E	E
Local Conflict of Interest	C	C	C	C	C	C	C	C	C	C
Water Usage & Rights	E	E	E	E	E	E	E	E	E	E
Sanitation	E	E	E	E	E	E	E	E	E	E
Accident	C	C	C	C	C	C	C	C	C	C
Infectious Diseases such as HIV AIDS	C	C	C	C	C	C	C	C	C	C
Natural Environment	E	E	E	E	E	E	E	E	E	E
Geographical Feature	E	E	E	E	E	E	E	E	E	E
Soil Erosion	C	B	C	C	C	C	C	C	C	C
Ground Water	E	E	E	E	E	E	E	E	E	E
Coastal Zone	E	E	E	E	E	E	E	E	E	E
Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E
Meteorology	E	E	E	E	E	E	E	E	E	E
Landscape	E	E	E	E	E	E	E	E	E	E
Global Warming	E	E	E	E	E	E	E	E	E	E
Pollution	E	E	E	E	E	E	E	E	E	E
Air pollution	E	E	E	E	E	E	E	E	E	E
Water Pollution	E	E	E	E	E	E	E	E	E	E
Solid Waste	E	E	E	E	E	E	E	E	E	E
Noise and Vibration	E	E	E	E	E	E	E	E	E	E
Ground Subsidence	B	C	C	E	C	E	E	E	C	E
Offensive Odour	E	E	E	E	E	E	E	E	E	E
Bottom Sediment	E	E	E	E	E	E	E	E	E	E

Source: Prepared by JICA Project Team

Source: JICA Project Team

**Table 14.4.3 Rating of Predicted Impacts
(Water Supply & Sewerage)**

IMPACTS	Overall Ratings									
	Water Supply					Sewerage				
	WS - 1	WS - 2	WS - 3	WS - 4	WS - 5	SE - 1	SE - 2	SE - 3	SE - 4	SE - 5
Social Environment	C	C	C	C	C	C	C	C	C	C
Local Economy	D	D	D	D	D	D	D	D	D	D
Employment, Livelihood	D	D	D	D	D	D	D	D	D	D
Land use, Utilization of Local Community	C	C	C	C	C	C	C	C	C	C
Existing Social Infrastructure & services	D	D	D	D	D	D	D	D	D	D
The poor, indigenous, and Ethnic People	E	E	E	E	E	E	E	E	E	E
Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C
Cultural heritage	E	E	E	E	E	E	E	E	E	E
Local Conflict of Interests	C	C	C	C	C	C	C	C	C	C
Water Usage & Rights	C	C	C	C	C	C	C	C	C	C
Sanitation	E	E	E	E	E	E	E	E	E	E
Accident	C	C	C	C	C	C	C	C	C	C
Infectious Diseases such as HIV AIDS	C	C	C	C	C	C	C	C	C	C
Natural Environment	E	E	E	E	E	E	E	E	E	E
Geographical Feature	E	E	E	E	E	E	E	E	E	E
Soil Erosion	E	E	E	E	E	E	E	E	E	E
Ground Water	C	C	C	C	C	C	C	C	C	C
Coastal Zone	E	E	E	E	E	E	E	E	E	E
Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E
Meteorology	E	E	E	E	E	E	E	E	E	E
Landscape	E	E	E	E	E	E	E	E	E	E
Global Warming	E	E	E	E	E	E	E	E	E	E
Pollution	E	E	E	E	E	E	E	E	E	E
Air pollution	E	E	E	E	E	E	E	E	E	E
Water Pollution	E	E	E	E	E	E	E	E	E	E
Solid Waste	E	E	E	E	E	E	E	E	E	E
Noise & Vibration	C	C	C	C	C	C	C	C	C	C
Ground Subsidence	E	E	E	E	E	E	E	E	E	E
Offensive Odour	C	C	C	C	C	C	C	C	C	C
Bottom Sediment	E	E	E	E	E	E	E	E	E	E

Source: Prepared by JICA Project Team

Source: JICA Project Team

**Table 14.4.4 Rating of Predicted Impacts
(Waste Management & Social Services)**

IMPACTS	Overall Ratings									
	Waste Management					Social Services				
	WM - 1	WM - 2	SS - 1	SS - 2	SS - 3	SS - 4	SS - 5	SS - 6	SS - 7	SS - 8
Social Environment	E	E	E	E	E	E	E	E	E	E
Local Economy	C	C	C	C	C	C	C	C	C	C
Employment, Livelihood	E	E	E	E	E	E	E	E	E	E
Land use, Utilization of Local Community	E	E	E	E	E	E	E	E	E	E
Existing Social Infrastructure & services	C	C	C	C	C	C	C	C	C	C
The poor, indigenous, and Ethnic People	E	E	E	E	E	E	E	E	E	E
Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C
Cultural heritage	E	E	E	E	E	E	E	E	E	E
Local Conflict of Interests	C	C	C	C	C	C	C	C	C	C
Water Usage & Rights	C	C	C	C	C	C	C	C	C	C
Sanitation	E	E	E	E	E	E	E	E	E	E
Accident	C	C	C	C	C	C	C	C	C	C
Infectious Diseases such as HIV AIDS	C	C	C	C	C	C	C	C	C	C
Natural Environment	E	E	E	E	E	E	E	E	E	E
Geographical Feature	E	E	E	E	E	E	E	E	E	E
Soil Erosion	E	E	E	E	E	E	E	E	E	E
Ground Water	C	C	C	C	C	C	C	C	C	C
Coastal Zone	E	E	E	E	E	E	E	E	E	E
Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E
Meteorology	E	E	E	E	E	E	E	E	E	E
Landscape	E	E	E	E	E	E	E	E	E	E
Global Warming	E	E	E	E	E	E	E	E	E	E
Pollution	E	E	E	E	E	E	E	E	E	E
Air pollution	E	E	E	E	E	E	E	E	E	E
Water Pollution	E	E	E	E	E	E	E	E	E	E
Solid Waste	E	E	E	E	E	E	E	E	E	E
Noise & Vibration	C	C	C	C	C	C	C	C	C	C
Ground Subsidence	E	E	E	E	E	E	E	E	E	E
Offensive Odour	C	C	C	C	C	C	C	C	C	C
Bottom Sediment	E	E	E	E	E	E	E	E	E	E

Source: Prepared by JICA Project Team

Source: JICA Project Team

CHAPTER 15 URBAN DEVELOPMENT PROGRAM AND PROJECT PROFILE

15.1 Project Programming

15.1.1 Principle for Project Programming

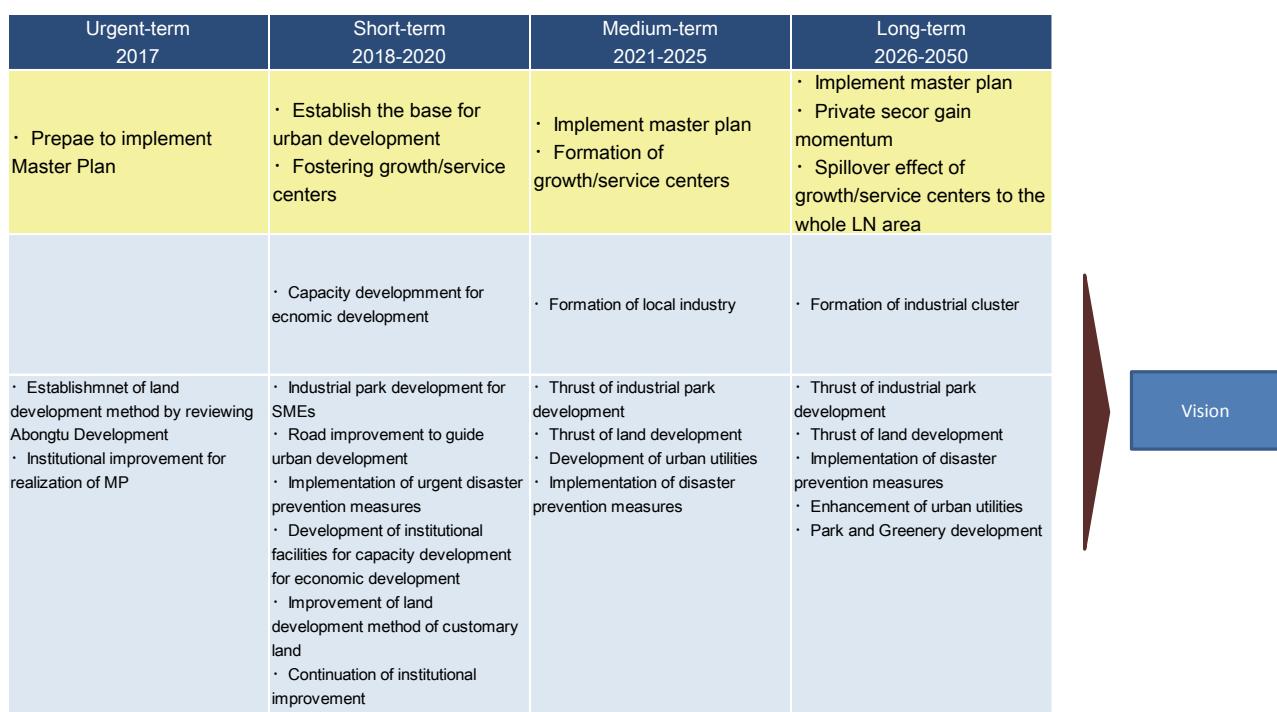
Following principles for project programming were established:

- Project program will be prepared based on the development strategies.
- Implementation stages are set for the periods of 2017, 2018–2020, 2021–2025, and 2026–2050
- In case initial project programming cannot be formulated due to budgetary constraints, the program will be adjusted.

- Future budgetary frame is estimated in consideration of present portion of the total budget.

In addition to the above principles, the following adjustments were applied:

- Usually, utility facilities such as those of water supply, sewerage, drainage and power supply are developed based on the road network; thus, road project as economic infrastructure will be prioritized among infrastructure projects.
- Disaster prevention projects minimizing large economic and human damages will be prioritized.
- Establishment of development method of customary land will be prioritized by studying ongoing Abongtu land development project.



Source: JICA Project Team

Figure 15.1.1 Development Stages for Project Programming

15.1.2 Estimate of Budgetary Framework for Master Plan

(1) Estimate of Capital Investment Frame

The budgetary framework of capital investment for LNUDP by PNG is estimated based on the above preconditions.

The annual budgetary framework for capital investment is some PGK 20 to 75 million, and total budgetary frame until 2025, the target year of LNUDP, is estimated between PGK 160 and 600 million.

(2) Project Cost of LNUDP M/P

Total estimated MP cost for the 8 years between 2018 and 2025 is over PGK 2,400 million, about PGK 310 million on the yearly average. The project cost is far beyond the capital investment budget. The project programming is reconsidered in an iterative way.

Table 15.1.1 Estimated Budgetary Framework of Capital Investment for LNUDP

Gov.	Funding Capacity (PGK million)	Allocation Rate to Lae-Nadzab Area	Budget frame (PGK million)
Central Gov.	Sum of capital investment budgets comprising Works & Implementation, Education, Higher Education and Health	1,309	1%—5% 13.1—65.5
	Capital investment budget allocated to Morobe Provincial Government	123	1%—5% 1.2—6.2
Prov. Gov.	Own funding resource	53	5% 2.6
LLG	Own funding resource	12	10% 1.2
Total Budget			about 20—75
Total budget of the 8 years between 2018 to 2015			about 160—600

Source: JICA Project Team

15.2 Project Program

The above project cost is estimated on condition that all project costs are funded by the governments. And operation and maintenance costs are not included.

However, beneficiary-pay principle can be

applied to those projects that are expected to generate revenue or income. For instance, water supply facilities and sewerage treatment facilities are provided by Water PNG, an independent and autonomous body from the central government, and construction costs of these facilities are finally borne by the users. Also in case of new urban development, sales/lease price of land should be set to cover the total project cost. The master plan projects that to be funded by the governments are confined within transport, flood control, and social service sectors.

As for the social service projects, the time span of the project is assumed until 2050 to reduce the yearly budget requirement. Total estimated cost of the 8 years between 2018 and 2025 by the governments is over PGK 290 million and some PGK 36 million on the yearly average. The project cost is within the capital investment budget frame.

There is no infrastructure developer funding mechanism or developer contribution scheme (like a tax credit scheme) for property development, and no link between private investment and delivery of infrastructure envisaged in urban development plan.

Table 15.2.1 Project Program

(I. Area of study: industrial development)			schedule										Remark									
	project title	proposed location	Development Scale		Expected Implementation Agency							-2016	-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	-2025	-2050
			Total	C&I		2025/2050	2025/2050	-2016	-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	-2025	-2025	-2050			
ID-1	Metal working industry development center	Kamkunun	30/40		MPA/ICDC			10				20							10			
ID-2	Wood working industry development center	Yalu industrial park	10/10		MPA/ICDC			5			5											
ID-3	Industrial vitalization cluster		20/20		MPA			20														
ID-4	Agro products consolidating depot	Tidal basin	5/15		MPA						5								10			
ID-5	Food processing industry development center based on setting up of empty-can manufacturing company	Malahang industrial area	5/5		ICDC					5												

(II. Area of study: Land Use)			schedule										Remark									
	project title	proposed location	Development Scale		Expected Implementation Agency							-2016	-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	-2025	-2050
			Total	C&I		2025/2050	2025/2050	-2016	-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	-2025	-2025	-2050			
LU-1	Lae Port North Zone (composite type)	Tidal Basin North Development (Including Javani Industrial Park)	100/600		by IPBC (Indep. Pub. Busi. Corp)			70				30						500				
			55/285					35			20							230				
			5/15																	Refer to ID-4		
			40/300			PNG Port Corporation		25		15								260		PNG Port corp.		

*The Project for the Study on Lae-Nadzab Urban Development Plan
in Papua New Guinea*

LU-2	Yalu Industrial Park Development	Yalu (composite type)	80-100/150		Industrial area Planned by MoI (ICDC)		60		30				60		
			50/100				30		20				50		Promoted by ICDC
			10/10												Refer to ID-2
			10/20	Growth Center: MPA			5		5				10		
			20/20	MPA											Refer to ID-3
			10/20				5		5				10		
LU-3	Wagan Fishery Park Development (composite type)	Wagan Industrial Zone Development (excluding port construction)	90/180-260	Including residences	Planned by FA				90				170		
			15/20	Promoted by FA					15				5		
			75/240						75				165		
LU-4	Airport City Development	Nearby area of Nadzab Airport (composite type)	130-150/500-900		to be done by MPA				150				750		
			9/100	Industria area by MPA					9				91		
			141/800						141				659		
LU-5	Ahi Rural (KamKanun Area) Settlement Expansion for 30,000	Ahi Rural Kamkanun	200-250/300		by MPA		50		200				50		
LU-6	Mahkham Bridge Road Side Service Center Development	Markham Point (composite type)	3/30-50		Michi-no-Eki by MPA		3						47		
			1/10	Commercial			1						9		
			2/40				2						38		
LU-7	Provincial Center Development at Lae old Airport	Lae Old Airport area (composite type)	15/90		by MP/A/ Private		5		10				75		Development completed: only road construction of 1 km length
			5/10	Commercial			5						5		
			10/80						10				70		
LU-8	New Urban Area Development at SITUM	Situm area (composite type)	10/10		Community Service Center by MPA		5		5						
LU-9	Labu Tourism Village Development	Labu area (I + II) Especially Labu-I (composite type)	0/200-300		Tourist Service Center by MPA								300		With Jeti Road: Refer to TR-5
			0/150										150		
			0/150										150		
LU-10	Kamkumun Industrial Area Development (composite type)	Kamkumun area	90/130		by MPA		20		70				40		Must with Industrial Development Refer to ID-1
			30/40												
			60/90				10		50				30		
LU-11	Gabensis Service Center Development	Gabensis area Community Center (composite type)	2/10		by MPA		2						8		
LU-12	Suburban Central Development along Yalu-Igam Bypass	Bumayong area Community & Commercial Center Improvement (including Bus Terminal)	100/400		by MPA				100				300		
			10/20						10				10		
			90/380						90				290		
LU-13	Eivots Garden Center North Development along Yalu-Igam Bypass	This project is planned in vast land along Yalu-Igam Bypass.	50/1000		by MPA				50				950		
			0/150										150		
			50/850						50				800		
LU-14	Eivots G.C. South Development	This project is planned in vast land along Yalu-Igam Bypass.	0/100-300		by MPA								300		
			0/10										10		
			0/290										290		
LU-15	3-mile Settlement Improvement	Neighboring area of Lae City (Development by community) Pilot Project	30/100		Initial Fund by MPA, Dev. Action by Community				50				800		Must as Polit Project, but area size is not specific
LU-16	Malahang Industrial Park	Western area of Busu Road	80/100		by MPA		50		30				20		To be developed by the industries that intend to invest
			75/95				45		30				20		
			5/5												Refer to L-5
LU-17	Puahom Garden City Development	Area along Busu Road	0/1000-1800		by MPA								1800		
			0/150										150		
			0/1650										1650		
LU-18	Bubia Industrial Park Development	Bubia	0/70		by MPA								70		
			0/50										50		
			0/20										20		
LU-19	Wampar Gate Development	Housing	30/100		by MPA				30				70		
LU-20	Abongtu Garden Villa	Area along Busu Road	44/44		by private company	22 22									

(III. Area of study: Road Transport)

	project title	proposed location	Development Scale		Expected Implementation Agency	schedule									Remark
			Total 2025/2050	C&I 2025/2050		-2017		-2020		-2025		-2050			
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
TR-1	Widening of North Bunbu Bridge and related roads	North Bunbu Bridge and its approaching roads	Construction of 2-lane bridge, L=50m Reconstruction of 2-lane bridge, L=50m Widening of Bunbu Road into 4-lane, L=1100m Construction of missing link with 2-lane, L=500m	by LULLG with MPA/DoW											
TR-2	Widening of Independence Drive	Independence Drive	Widening into 4-lane, L=3.1km	by LULLG with MPA/DoW											
TR-3	Widening of Markham Bridge	Markham Bridge	1-lane new bridge L=560m	by DoW											
TR-4	Widening of Bukawa Road	Bukawa Road	Widening into 2-lane, L=2.1km Reconstruction of two bridges with 2-lane, L=60m & 30m	by DoW											
TR-5	Construction of Yalu-Igam Highway	Area between Yalu and Igam	2-Lane Paved L=14km	by District Office with MPA/DoW											
TR-6	Construction of Bypass Highway behind Lae Tidal Basin	Area behind Lae Tidal Basin	2-Lane Paved L=7.2km	by LULLG with MPA/DoW											
TR-7	Construction of Collector Roads between Independence Drive and Busi Road	Ahi Rural Kamkumun area	5 new roads with 2-lane, L=17.4km	by District Office with MPA/DoW											
TR-8	Rehabilitation of Lae City Roads	Lae City	Two roads with 2-lane, L=8.1km	DOW											
TR-9	Rehabilitation of two access roads to Labu areas	Labu area	Two gravel roads with 1-lane, L=30km	by MPA											
TR-10	Construction of PMV Terminals	Main Market area, Eriku area and Nadzab Airport City	3 terminals with concrete pavement (A=0.6ha for each)	by LULLG											
TR-11	Feasibility Study for Railway between Highlands Region and Lae	Between Highlands Region and Lae		DOT											
TR-12	Technical Assistance for PMV Management			MPA											
TR-13	Technical Assistance for Road Maintenance			LULLG											
TM-1	Construction of Jetties for Labu	Labu area	3 jetties	District Office											
TM-2	Development of Fisheries Wharf in Wagang	Wagang village	Construction of fisheries wharf Construction of access road	by National Fishery Authority (Phase 1)											

(IV. Area of study: Storm Water Drainage)

	project title	proposed location	Development Scale		Expected Implementation Agency	schedule									Remark
			Total 2025/2050	C&I 2025/2050		-2017		-2020		-2025		-2050			
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
SD-1	River Improvement in the lower reaches of the Markham River	The lower reaches of Markham River	50-year return period		Department of Works, PNG										
SD-2	Ground Raising	The right bank site of the Markham Bridge in the Markham River	50-year return period		Department of Works, Morobe					2.79	2.79				The project cost shall be integrated in LU-6.
SD-3	River Improvement of the Erap River	The Erap River	50-year return period		Department of Works, PNG							7.08	7.08	7.08	
SD-4	River Improvement of the lower reaches of the Bumbu River	The lower reaches of the Bumbu River	50-year return period		Department of Works, PNG					2.74	2.74	2.74	2.74	2.74	
SD-5	River Improvement of the upper reaches of the Bumbu River	The lower reaches of the Bumbu River	50-year return period		Department of Works, PNG										
SD-6	River Improvement of the lower reaches of the Busu River	The lower reaches of the Busu River	50-year return period		Department of Works, PNG										

*The Project for the Study on Lae-Nadzab Urban Development Plan
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(V. Area of study: Water Supply)

	project title	proposed location	Development Scale		Expected Implementation Agency	schedule									Remark
			Total	C&I		-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	-2025	
			2025/2050	2025/2050		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
WS-1	Water Supply Development in Lae	Lae urban and Abi Rural between Markham River and Busu River			Water PNG										
WS-1-1	Rehabilitation and Function Enhancement	Existing Water Supply Area and others	Water source Submersible pump	Water PNG											
WS-1-2	Tidal Basin North	Lae Port North Zone (composite type)	Pipeline	Water PNG											
WS-1-3	Wagan Fishery Villa	Wagan Industrial Zone Development (excluding port construction)	Pipeline	Water PNG											
WS-1-4	Ahi Central	Ahi Rural Kamkanun	Pipeline	Water PNG											
WS-1-5	Provincial Central at Lae Old Airport	Lae Old Airport area (composite type)	Pipeline	Water PNG											
WS-1-6	Kamkunun Light Industry	Kamkunun area	Pipeline	Water PNG											
WS-1-7	Buimo Garden Villa	Buimo area	Pipeline	Water PNG											
WS-1-8	Igam Garden Villa	North of Bumayong area	Pipeline	Water PNG											
WS-1-9	Abong Garden Villa	Bumayong area	Pipeline	Water PNG											
WS-1-10	Suburban Central along Yalu-Igam Bypass	Yalu-Igam Bypass	Booster Pump Station Booster Pump Pipeline	Water PNG											
WS-1-11	Eivots Garden City North along Yalu-Igam Bypass		Pipeline	Water PNG											
WS-1-12	Eivots Garden City South		Pipeline	Water PNG											
WS-1-13	3-mile Settlement Improve	Neighboring area of Lae City (Development by community) Pilot Project	Pipeline	Water PNG											
WS-1-14	Malahang Industrial Expansion	Malahang area	Pipeline	Water PNG											
WS-1-15	Wampar Gate at 5-6 miles	West of Lae city	Pipeline	Water PNG											
WS-2	SITUM	Situm area (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-3	Puahom Garden City		Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-4	Bubia Industrial Park		Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-5	Yalu Industrial Park	Yalu (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-6	Nadzab Airport City	Nearby area of Nadzab Airport (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-7	Markham Bridge	Markham Point (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-8	Gabensis	Gabensis area Community Center (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											
WS-9	Labu Garden Villa along Markham River	Labu area (I + II) Especially Labu-I (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG											

*The Project for the Study on Lae-Nadzab Urban Development Plan
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(VI. Area of study: Sewerage)

	project title	proposed location	Development Scale		Expected Implementation Agency	schedule										Remark	
			Total	C&I		-2017		-2020		-2025		-2050					
			2025/2050	2025/2050		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025		
SW-1	Sewerage Development in Lae Phase-1	Lae urban and Ahi Rural between Markham River and Busu River, Southern area than Taraka															
SW-1-1	Rehabilitation and Function Enhancement	Existing Sewer Area	Rehabilitation of sewer network (2,452ha) Pump station to STP	Water PNG													
SW-1-2	Lae Sewage Treatment Plant (STP) PH-1	Tidal Basin North	41,000m ³ /day	Water PNG													
SW-1-3	Provincial Center Development at Lae old Airport PH-1	Lae Old Airport area	Sewer network (80ha)	Water PNG													
SW-1-4	3-mile Settlement Improve	3-mile Settlement	Sewer network (41ha)	Water PNG													
SW-1-5	Wampar Gate Development PH-1	Housing area	Sewer network (60ha)	Water PNG													
SW-2	Sewerage Development in Lae Phase-2	Lae urban and Ahi Rural between Markham River and Busu River, Taraka & Northern area than Taraka															
SE-2-1	Rehabilitation and Extension	Existing Sewer Area in Taraka / UNITEC and Surroundings	Rehabilitation / Extension of Sewer network (758ha)	Water PNG													
SW-2-2	Lae Sewage Treatment Plant (STP) PH-2	Tidal Basin North	41,000m ³ /day extenssion Extension of Pump station to STP	Water PNG													
SW-2-3	Sewer Extension along Independence Road	Along Independence Road between Buimo and Omili	Sewer network (284ha)	Water PNG													
SW-2-4	Provincial Center Development at Lae old Airport PH-2	Lae Old Airport area	Sewer network (75ha)	Water PNG													
SW-2-5	Tidal Basin North Development	Lae Port North Zone	Sewer network (600ha)	Water PNG													
SW-2-6	Wagan Fishery Park Development	Wagan Industrial Zone Development (excluding port construction)	Sewer network (180ha)	Water PNG													
SW-2-7	Ahi Rural (KamKanun Area) Settlement Expansion for 30,000	Ahi Rural (KamKanun)	Sewer network (140ha)	Water PNG													
SW-2-8	Kamkunun Industrial Area Development (composite type)	Kamkunun area	Sewer network (130ha)	Water PNG													
SW-2-9	Wampar Gate Development PH-2	Housing area	Sewer network (40ha)	Water PNG													
SW-2-10	Malahang Industrial Park	Malahang	Sewer network (240ha)	Water PNG													
SW-3	Suburban Central Development along Yalu-Igam Bypass	Bumayong area Community & Commercial Center Improvement (including Bus Terminal)	PH-1: Sewage Treatment Plant (1,500m ³ /d) Sewer network (140ha) PH-2: Sewage Treatment Plant (3,000m ³ /d extension) Sewer network (400ha)	Water PNG													
SW-4	Eivots Garden Center North Development along Yalu-Igam Bypass	Along Yalu-Igam Bypass	PH-1: Sewage Treatment Plant (3,000m ³ /d) Sewer network (230ha) PH-2: Sewage Treatment Plant (15,000m ³ /d extension) Sewer network (820ha)	Water PNG													
SW-5	Eivots G.C. South Development	Along Yalu-Igam Bypass	Sewage Treatment Plant (7,000m ³ /d) Sewer network (700ha)	Water PNG													
SW-6	Puahom Garden City Development	Puahom	Sewage Treatment Plant (7,000m ³ /d) Sewer network (800ha)	Water PNG													

*The Project for the Study on Lae-Nadzab Urban Development Plan
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(VII. Area of study: Solid Waste Management)

	Project Title	Proposed Location	Development Scale		Expected Implementation Agency	Schedule										Remark	
			Total	C&I		-2017		-2020		-2025		-2050					
			2025/2050	2025/2050		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025		
WM-1	Rehabilitation of the Existing Dumpsite	Construction of sanitary landfill	3.5 ha	Lae District												3 million/ha	
		Closure of existing dumping site	7.5 ha														
WM-2	Construction of new sanitary landfill	Behind Tidal Basin North zone	16 ha	Lae District												3 million/ha	
WM-3	Expansion of solid waste collection system	Lae District and the other districts	Coverage population forecast: in 2015: 84,000 in 2025: 99,000	Lae District: Outsourcing													
WM-4	Construction of new sanitary landfill	Nazab Airport City	1.0 ha/1.5 ha	Wampar District												3 million/ha + adm. Build.	

(VIII. Area of study: Social Service)

CHAPTER 16 IMPLEMENTATION STRATEGY

16.1 Strategic Policy Coordination between Development Plans

Formulation of the following plans is proposed.

Provincial Economic and Social Development Strategic Plan with a target period of ten to twenty years as a basis for formulation of

an Urban Development Plan

Subject Development Plans stipulated in the Physical Planning Act for appropriate development of physical infrastructure and public utility proposed in the Urban Development Plan

Local Development Plans stipulated in the Physical Planning Act for implementation of proper land use regulation (zoning).

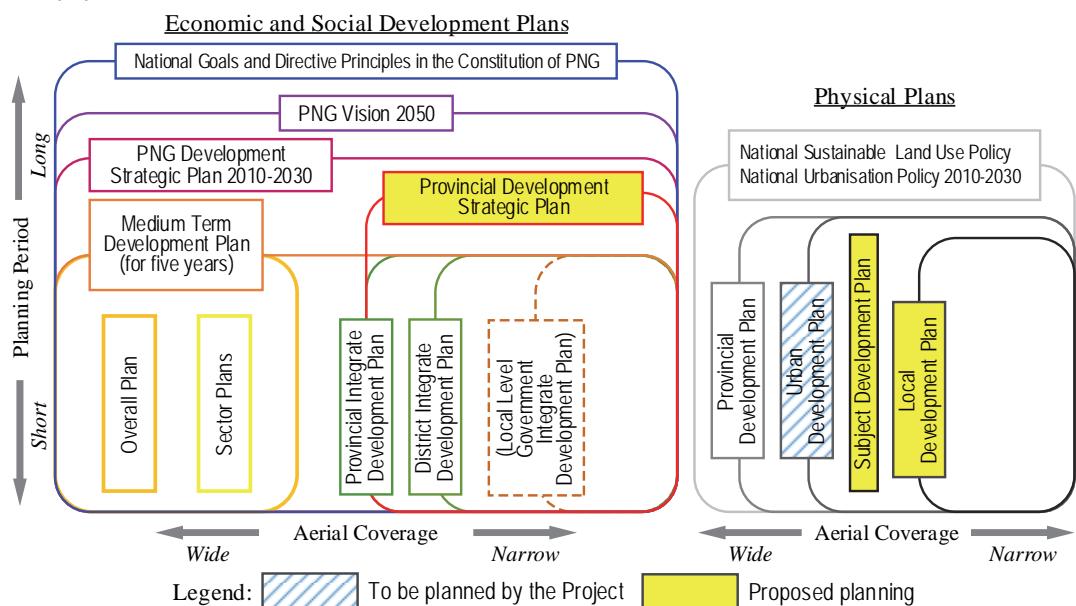


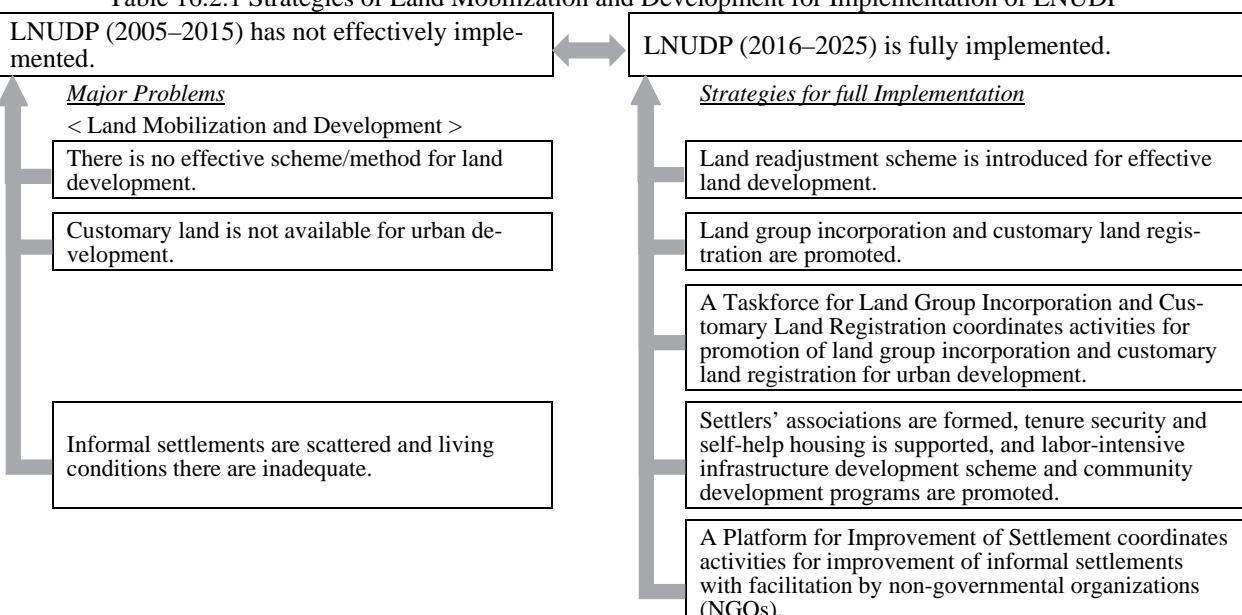
Figure 16.1.1 Existing and Proposed Development Plans of PNG

16.2 Strategies of Land Mobilization and Development

Strategies of land mobilization and development

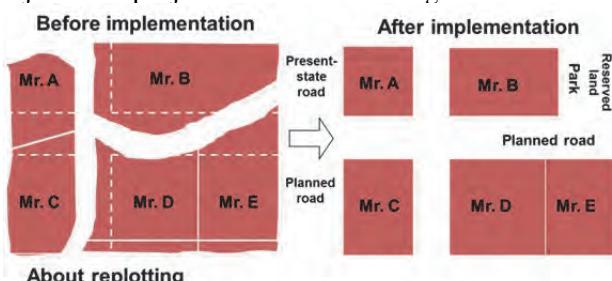
for full implementation of Lae-Nadzab Urban Development Plan (LNUDP) are shown in Table 16.2.1.

Table 16.2.1 Strategies of Land Mobilization and Development for Implementation of LNUDP



Source: JICA Project Team

Concept of replotting in a proposed land readjustment project is illustrated in Figure 16.2.1.



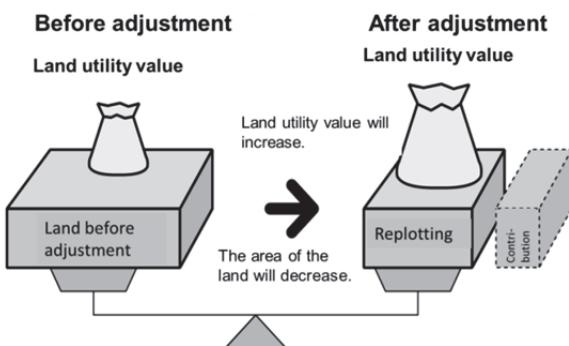
About replotting

Replotting is to reallocate present-state land according to the arrangement of a new road and a park .

Source: City Planning Div., Civil Engineering Dept., Miyagi Prefecture - Material for the Counterpart Training in Japan

Figure 16.2.1 Concept of Land Replotting

Concept of contribution of land and land value increase in a proposed land readjustment project is depicted in Figure 16.2.2.



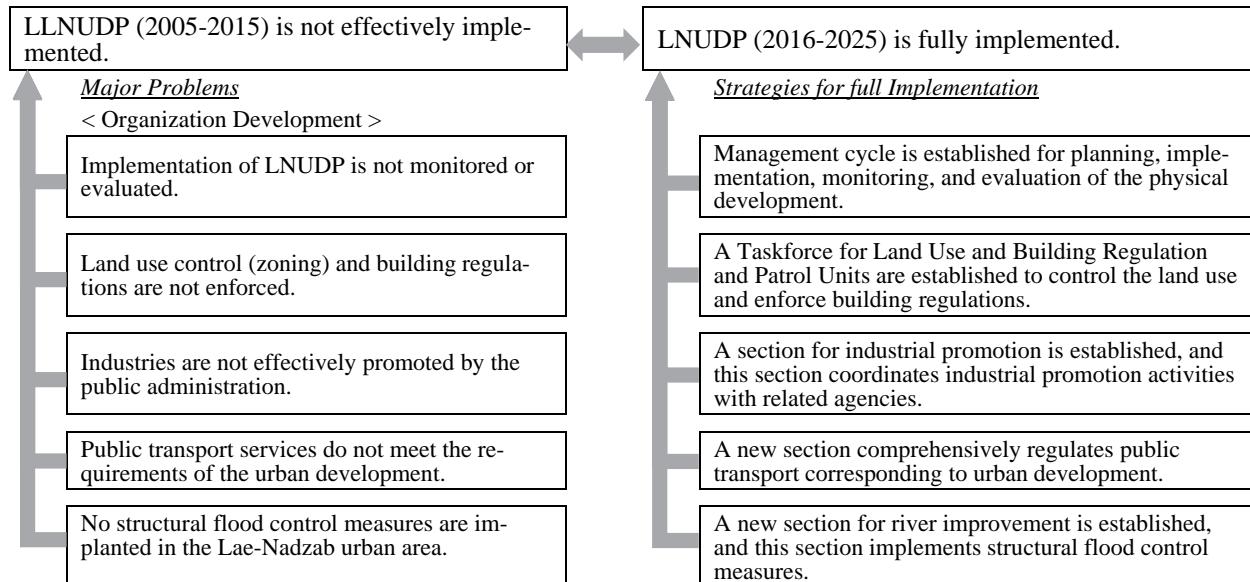
Source: City Planning Div., Civil Engineering Dept., Miyagi Prefecture - Material for the Counterpart Training in Japan

Figure 16.2.2 Concept of Contribution of Land and Land Value Increase

16.3 Strategies of Organization Development

Strategies of organization development to secure the implementation of LNUDP are given in Table 16.3.1.

Table 16.3.1 Strategies of Organization Development for Implementation of LNUDP



Source: JICA Project Team

PART III

PRE-FEASIBILITY STUDY OF PRIORITY PROJECT

CHAPTER 17 SCOPE OF THE PROJECT

17.1 Project Objectives

The Highlands Highway is the most important highway in the country serving as a “backbone infrastructure” connecting the PNG’s biggest port at Lae with the inland Highlands provinces which account for about 40 percent of the country population and have vast natural resources. The highway is currently under construction to widen the section between the Bugandi Roundabout (intersection with Boundary Road) and Nadzab Airport into four lanes. However, there is no plan to widen the section from the Bugandi Roundabout to Lae Port, and it will remain as it is and get congested in the near future.

Furthermore, Lae Tidal Basin Project is also on-going and it includes the development of its hinterland to industrial area; therefore, the traffic demand of this two lane section will rapidly increase.

Under such situation, the new proposed bypass road connecting Lae Port to the Highlands Highway is really required, and it is expected:

- ✓ To separate port related traffic, especially heavy trailers, from general traffic in Lae central area,
- ✓ To guide future urbanization and function as the arterial road of the expected development area, and
- ✓ To provide an alternative route of the Highlands Highway for emergency cases.

The construction of the Bypass Highway behind Lae Tidal Basin (hereinafter the Bypass) was selected from several priority projects proposed in the master plan and approved for pre-feasibility study by the third Join Coordination Committee meeting held on 27 April 2016.

17.2 Circumstances

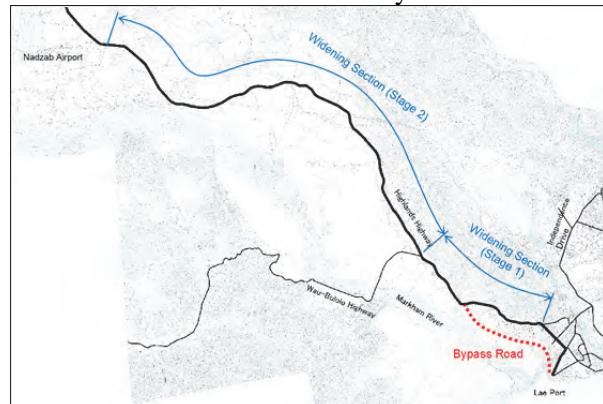
17.2.1 Related Infrastructure Developments

(1) Highlands Highway Reconstruction & Upgrading Project

As explained in Section 6.1 and 17.1, the Highlands Highway from Bugandi roundabout till Nadzab Airport junction is being widened to 4 lanes under the funding of PNG government. The widening project is divided into two stages as follows:

Stage 1: from Bugandi roundabout (at 2-Mile) to Wau junction (at 9-Mile): 8.6 km
Construction period: Sept. 14–Sept. 16
Contractor: China Railway International

Stage 2: from Wau junction (at 9-Mile) to Nadzab Airport junction: 25.9 km
Construction period: Nov. 15–Nov. 17
Contractor: Not awarded yet



Source: JICA Project Team

Figure 17.2.1 Location of Highlands Highway

The right-of-way extends 20 meters on each side of the center line, and Figure 17.2.5 shows a typical cross section of the highway.

(2) Lae Tidal Basin Project

As explained in Section 6.2, the Lae Port is being expanded by ADB loan with dredging a tidal basin and construction of a new wharf beside tidal basin in order to facilitate large container vessel services. The project is divided into two phases, and the first phase was completed in December 2014 and started service. In the second phase, the tidal basin and the wharf will be extended to make it capable of catering for much larger vessels.

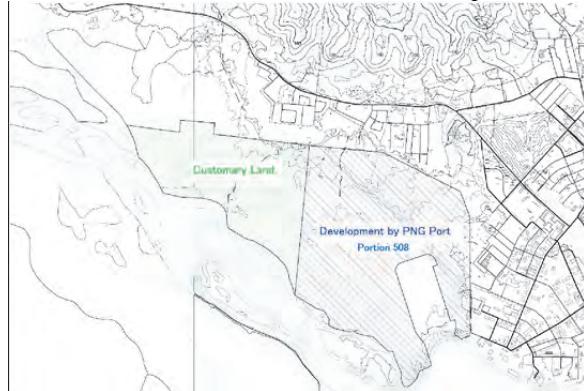
17.2.2 Topographical Conditions

As the area targeted for the Bypass is close to Markham River, the land is low-lying, swampy and often flooded. Although, the northern area, which is relatively high and close to the Highlands Highway, has been developed as a residential area, the southern area is close to the river and always swampy and has a few houses.

As shown on Figure 17.2.2, the area colored in blue including Lae Tidal Basin Project area has been entrusted to PNG Ports Corporation to develop it into industrial area, and the area was named as Portion 508 (refer to Figure 17.2.3). The area has been acquired and the resettlement of the residents has been completed by ADB. However, a few houses returned back to this

area after the resettlement, and one small village remains as it is. In order to avoid further encroachment, PNG Ports Corporation has built the fence along the boundary of Portion 508 together with access road (see Figure 17.2.4).

As shown on Figure 17.2.2, the area colored in green located on the west side of the Portion 508 is customary land and it is under dispute between two clans who claim ownership.



Source: JICA Project Team

Figure 17.2.2 Location Map of Lae Tidal Basin North Project



Source: PNG Ports Corporation

Figure 17.2.3 Tentative Layout Plan of Portion 508

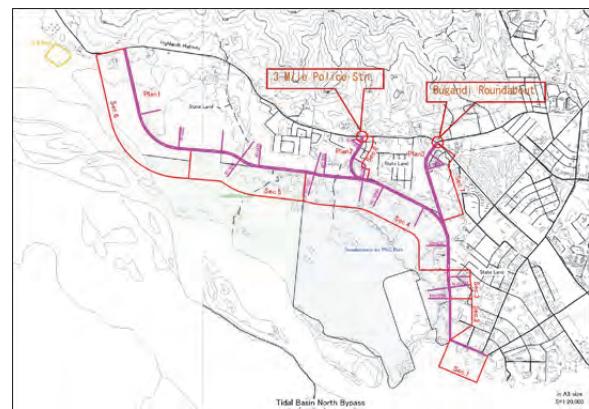
17.3 Outline of the Project

Taking account of circumstances mentioned above, the Bypass could be proposed from Lae Port to 6-Mile area of Highlands Highway, where urban area ends and space for the road

development is available, and it could be set along the boundary of the Portion 508 and the customary land. However, based on the expected future development, and possibility of funding constraints, two more alternative routes of the Bypass are proposed, one which intersects with the Highlands Highway at 3-Mile police station and another at Bugandi roundabout. According to the PNG Ports, the full development of the Lae Tidal Basin is expected to take 15 to 20 years. Therefore, the road may be constructed in phases taking into account the level of port development and subsequent traffic growth, and availability of the fund.

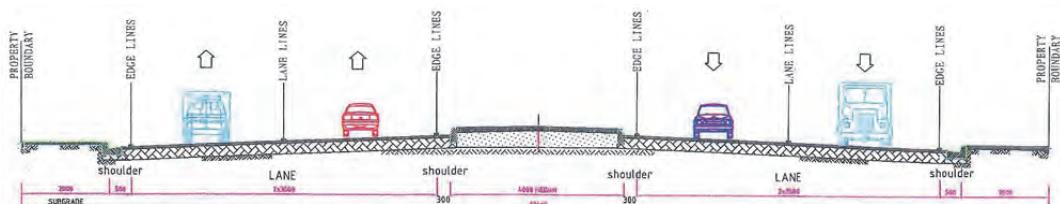


Source: JICA Project Team
Figure 17.2.4 Fence along Portion 508 Boundary



Source: JICA Project Team

Figure 17.3.1 Alternative Routes of Bypass



Source: Highlands Highway Reconstruction & Upgrading Project

Figure 17.2.5 Typical Cross Section of Stage 1 of Highlands Highway Project

CHAPTER 18 TRAFFIC DEMAND FORECAST

This chapter evaluates the total travel time that could be saved and the total travel distance that could be reduced by the construction of each of the alternative bypass routes proposed in Section 17.3.

18.1 Long-term Traffic Demand

The future traffic demand up to 2025 is based on the details of the development plans specified in the master plan. The traffic volume expected in 2025 is, therefore, calculated based on the planned land use changes in each zone as well as the expected socioeconomic development. The pre-feasibility study of the bypass road, however, requires a longer span (up to the year 2050) future traffic analysis.

It is difficult to get zone-level land use changes beyond the master plan target year (2025). The future traffic demand beyond the year 2025 is, therefore, based on the socioeconomic trend. The passenger traffic is estimated on the assumption that population will grow at the current average annual growth rate of 2.5%, and the passenger traffic will also grow at the same rate. Although currently the share of public motor vehicles (PMV) is very high, accounting for 75% of the motorized trips (excluding trucks), this share is expected to decrease with economic growth and subsequent motorization. The future share of the PMV would depend on many factors, particularly government policies. It is, therefore, assumed that the share of the cars would increase from its current 25% to 60% by 2050 as the government would adopt policies that would protect the PMV share from getting below 40% by 2050.

Truck traffic growth is closely linked to the economic growth. The Lae Tidal Basin appraisal is based on average growth of 6% of cargo traffic. This rate is developed based on the cargo and economic growth trends. This study has adopted the same rate (6%) to forecast the future truck traffic.

18.2 Alternative Routes

As mentioned at the beginning, three alternative routes are considered (see Section 17.3). The three alternatives are as follows:

Route 1: A 7.7-km road that starts from the port area and intersects the Highlands Highway at 6-Mile

Route 2: A 4.2-km road that starts from the port area and intersects the Highlands Highways at 3-Mile Police Station.

Route 3: A 3.4-km road that starts from the port area and intersects the Highlands Highways at Bugandi Roundabout.

Figure 18.2.1 to Figure 18.2.3 show the bypass traffic in 2025, for each of the above three alternatives. In addition, Table 18.2.1 shows the traffics forecast up to 2050 by route. The following sections analyze the impact of each alternative in detail.

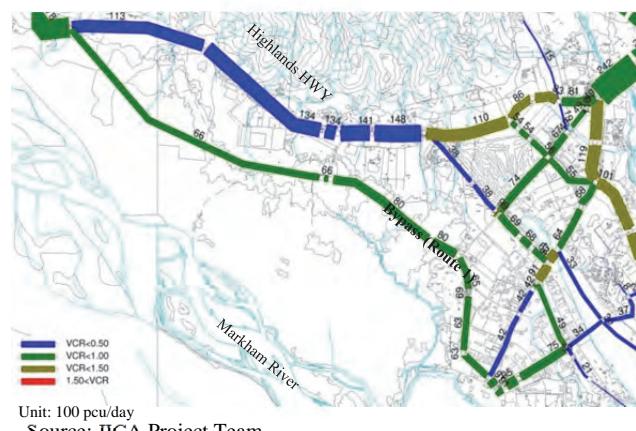


Figure 18.2.1 Daily Bypass Traffic in 2025 (Route 1)

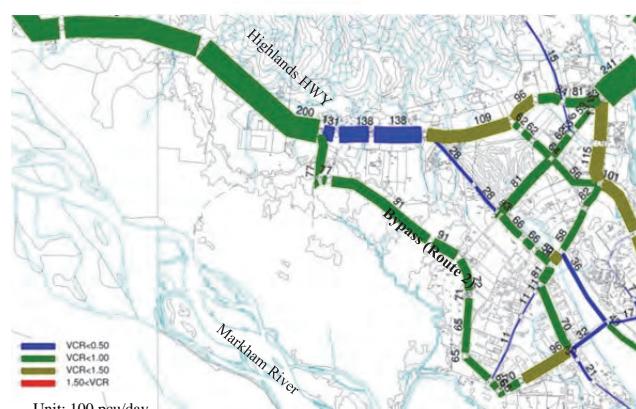


Figure 18.2.2 Daily Bypass Traffic in 2025 (Route 2)

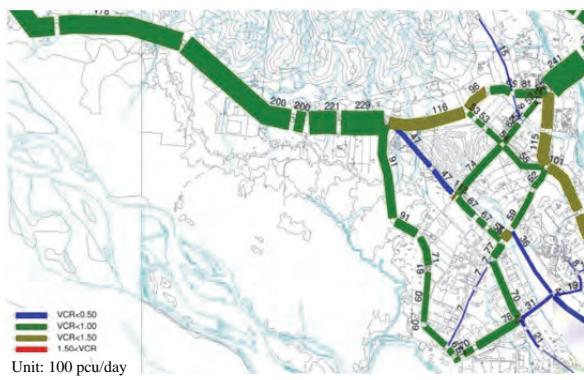


Figure 18.2.3 Daily Bypass Traffic in 2025 (Route 3)

Table 18.2.1 Daily Bypass Traffic by Year

Alternative	Maximum Link Traffic by Year (pcu/day)				
	2020	2025	2030	2040	2050
Route 1	6,193	8,039	9,254	11,917	15,078
Route 2	7,116	9,137	10,600	13,041	15,882
Route 3	7,375	9,121	11,141	12,951	16,189

Source: JICA Project Team

18.3 Future Network

The bypass road is expected to be completed by 2020. Therefore, the impact of the bypass road is evaluated at ten-year intervals, starting from the expected opening year (2020) until 2050. Although the expected network changes in the base case were considered for the years up to 2030, the base network beyond 2030 was assumed to remain unchanged.

The following section evaluate how each of the above alternatives affects the overall performance (in terms of travel time, and travel distance).

18.4 Traffic Analysis

The total travel time and the total travel distance of the network are calculated for two cases: with bypass and without bypass cases. The travel time and travel distance are estimated at 10-year intervals, *i.e.*, for the years 2020, 2030, 2040 and 2050, and the differences are calculated to evaluate how the construction of the bypass could affect the performance of the network. Table 18.4.1 shows the daily travel time and travel distance changes for each bypass route option. As the result shows, both travel time and travel distance decrease with the construction of the routes.

Table 18.4.1 Daily Travel Time and Travel Distance Changes of Traffic

Year	Mode	Route 1		Route 2		Route 3		Change in time (veh-km)	Change in distance (veh-km)	
		Change in time		Change in distance (veh-km)	Change in time		Pass. vehicles (pass-hr)	Trucks (veh-hr)		
		Pass. vehicles (pass-hr)	Trucks (veh-hr)		Pass. vehicles (pass-hr)	Trucks (veh-hr)				
2020	Car	-396	—	-967	-413	—	-1,217	-307	—	-43
	PMV	-1,037	—	-598	-1,055	—	-750	-750	—	9
	Truck	—	-46	-1,670	—	-52	-1,902	—	-50	-1,859
2030	Car	-993	—	-1,802	-1,014	—	-2,403	-822	—	-398
	PMV	-1,673	—	-702	-1,673	—	-944	-1,334	—	-116
	Truck	—	-77	-2,315	—	-86	-2,729	—	-90	-2,863
2040	Car	-2,279	—	-3,292	-2,237	—	-4,124	-1,934	—	-1,388
	PMV	-2,493	—	-852	-2,414	—	-1,070	-2,066	—	-312
	Truck	—	-134	-3,047	—	-142	-3,587	—	-140	-3,584
2050	Car	-6,071	—	-6,808	-6,134	—	-9,350	-5,478	—	-4,336
	PMV	-4,820	—	-1,199	-4,794	—	-1,683	-4,253	—	-670
	Truck	—	-266	-4,179	—	-282	-4,872	—	-268	-4,709

Source: JICA Project Team

CHAPTER 19 PRELIMINARY DESIGN

19.1 Route Planning

(1) Alternative routes

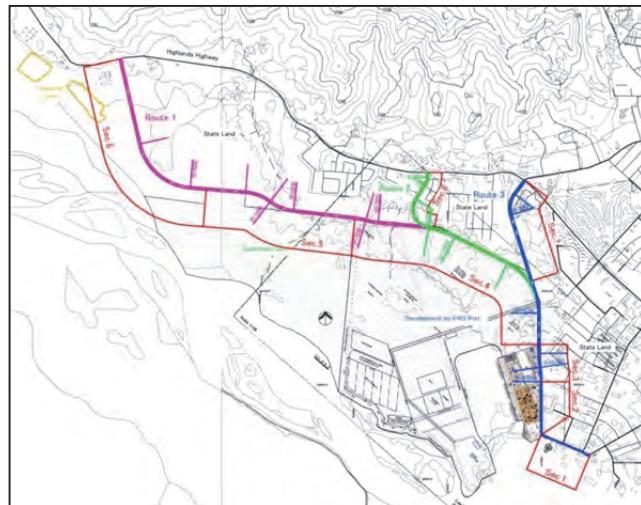
The Bypass shown in the Master Plan starts at the entrance of the new Lae Port, and heads north-west along the border of the Portion 508. The Bypass then proceeds toward west, partly touching the northern edge of customary land, and finally heads north-west again before intersecting with Highlands Highways at a point in 8-Mile area (about 8 miles from the city center). The cost of the project is expected to be significantly high; therefore, the study team proposed the following three (3) alternatives as explained in Section 18.2:

Route 1:A 7.70-km road that intersects the Highlands Highway at 6-Mile

Route 2:A 4.15-km road that intersects the Highlands Highways at 3-Mile Police Station.

Route 3:A 3.35-km road that intersects the Highlands Highways at Bugandi Roundabout.

The locations of each route are shown in Figure 19.1.1.



Source: JICA Project Team

Figure 19.1.1 Alternative Routes

Table 19.1.1 shows comparison of each route profile.

Table 19.1.1 Comparative Table of the Bypass Routes

	Route 1	Route 2	Route 3
Objective	The bypass passes the Lae Tidal Basin port development project area internal circumference vicinity, and in front of Aigris Market, and it intersects with the Highlands Highway at 8-Mile area (near the crocodile farms without affecting them) via the northern edge of the customary land.	The bypass passes the Lae Tidal Basin port development project area internal circumference vicinity, and in front of Aigris Market, and it intersects with the Highlands Highway at 3-Mile Police Station. Section 8 of the existing road will be widened.	The bypass passes the Lae Tidal Basin port development project area internal circumference vicinity, and in front of Aigris Market, and it intersects with the Highlands Highway at the Bugandi Roundabout.
Length	7.70 km	4.15 km	3.35 km
Function of the bypass	Since the route connects to the Highlands Highway at 8-Mile area, away from commerce, industries and houses on the Highlands Highway, it is expected to separate city traffic and the tidal basin related traffic.	It is planned to separate the city traffic and the tidal basin related traffic in the central city area, but the two types of traffic will mix at the western side of the 3-Mile Police Station on the Highlands Highway.	It is planned to separate the city traffic and the tidal basin related traffic in the central city area, but the two types of traffic will mix at the western side of the Bugandi Roundabout on the Highlands Highway.
Effect on Urban Development	The bypass has the potential to initiate the development of commerce, industries and houses related to the Lae Tidal Basin port from 4.2 km to the end point of the route.	Since the route passes the Lae Tidal Basin port development project area internal circumference vicinity and existing housing area, it is difficult to develop a new city zone.	Same as Route 2. However there is undeveloped area along 500 m of the bypass on its east side. So this area has the potential to be a small scale city zone.
Effect on Transportation	The bypass will serve not only traffic related to Lae Port but also traffic related to north-west development areas. It will also serve as an alternative route to Highlands Highway between Bugandi Roundabout and Lae Port which will not be widened.	The bypass will serve traffic related to Lae Port; however, comparing with Route 1, the effect on traffic related to north-west development areas is relatively small. It will also serve as an alternative route to Highlands Highway between Bugandi Roundabout and Lae Port which will not be widened.	The bypass will serve traffic related to Lae Port; however, comparing with Route 1 & 2, the effect on traffic related to north-west development areas is small. It will also serve as an alternative route to Highlands Highway between Bugandi Roundabout and Lae Port which will not be widened.
Land Acquisition & Resettlement	Since the bypass uses existing roads and edges of the Lae Tidal Basin port project from the beginning point to 4.2 km point, resettlement is not necessary. However, there are 3 or 4 small huts. The bypass passes through state land, and no settlement or houses are seen.	Since the bypass uses existing roads and edges of the Lae Tidal Basin port project from the beginning point to 3.4 km point, resettlement of 5 to 10 houses in section 8 is necessary.	Since the bypass uses existing roads and edges of the Lae Tidal Basin port project from beginning point to 2.0 km point, resettlement is not necessary. The bypass also passes through 1.3 km of the grassland up to the Bugandi Roundabout. So, resettlement is not necessary.
Several small huts stand inside the tidal basin phase II area, but they will be removed before the bypass starts construction.			

Source: JICA Project Team

19.2 Geometric Planning

(1) Profile

The topography from the beginning point of the bypass to the end point is flat. This area is flooded with a maximum flood level of 1 meter above the ground in rainy season, according to interviews with residents. Therefore, proposed height of the Bypass to be developed on flood area is set at 1.5 m above the ground level taking account of the floods. Proposed height of the Bypass to be developed on existing roads is 0.5 m considering the approach between housing area and existing road.

(2) Typical cross section

Since expected traffic is about 9,000 pcu/day, the Bypass will be developed as a 2-lane road, one in each direction. A lane is set 3.5 m wide and shoulder is set 1.5 m wide; and median strip width is set a 1.0 m because of the high large truck traffic. Sidewalk widths are set as 2.5 m on both sides. The total width of the bypass is 15 m. The ground condition in this area is soft (discussion with PNG Port Corporation). So, it is assumed that the settlement would be 1.0 m per 1.5 m of embankment height. The sand mat of thickness 50 cm is set on the ground to promote settlement development.

The pavement structure is based on the standard note of DOW, and a typical cross section of the bypass is shown in Figure 19.3.1.

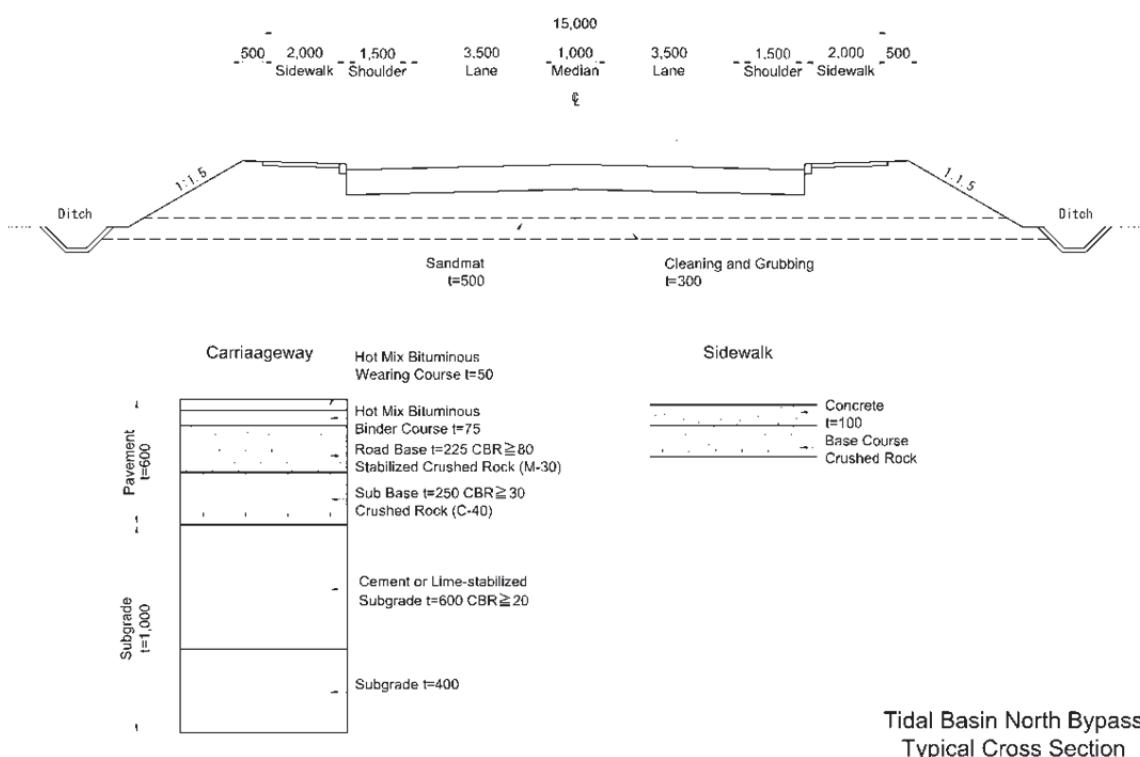
19.3 Drainage Planning

Lae is the 5th wettest city on earth with more than 4,000 millimeters of annual rainfall. Lae has a tropical climate; dry season tends to be from November to April, and wet/rainy season from May to October.

The topography of this area consists of 2 types: a hilly area in the northern part, and a flat area in the southern part. The Highlands Highway passes along the foot of the hilly area in east and west.

Rainwater flows through a valley between hilly areas, and then crosses drainage system of the Highlands Highway, and flows to the flat area where a few canals exist.

Side ditches will be constructed on both sides of the Bypass, and pipe culverts (with diameter of 1,000 mm) across the Bypass at 100-m intervals are to be installed. In next design stage, it is necessary to adjust the drainage plans based on detail rainfall data and information of Lae Tidal Basin project.



Source: JICA Project Team

Figure 19.3.1 Typical Cross Section of the Tidal Basin North Bypass

CHAPTER 20 CONSTRUCTION PLAN

20.1 Work Plan

20.1.1 Construction Schedule

As the construction period depends on the length of the road, it is different for each route. The construction periods of Route 1, 2 and 3 are assumed to be 41 months, 24 months and 20 months, respectively. The work schedules are shown in Figure 20.1.1 to 20.1.3.

Description	2019	2020	2021	2022
Construction Period			41 months	
Preparatory Work	■			
Earth Work	■			
Pavement		■		
Road Furniture & Road Markings			■	
Demobilization			■	

Source: JICA Project Team

Figure 20.1.1 Construction Schedule of Route 1
(41 months)

Description	2019	2020	2021	2022
Construction Period			24 months	
Preparatory Work	■			
Earth Work	■			
Pavement		■		
Road Furniture & Road Markings			■	
Demobilization			■	

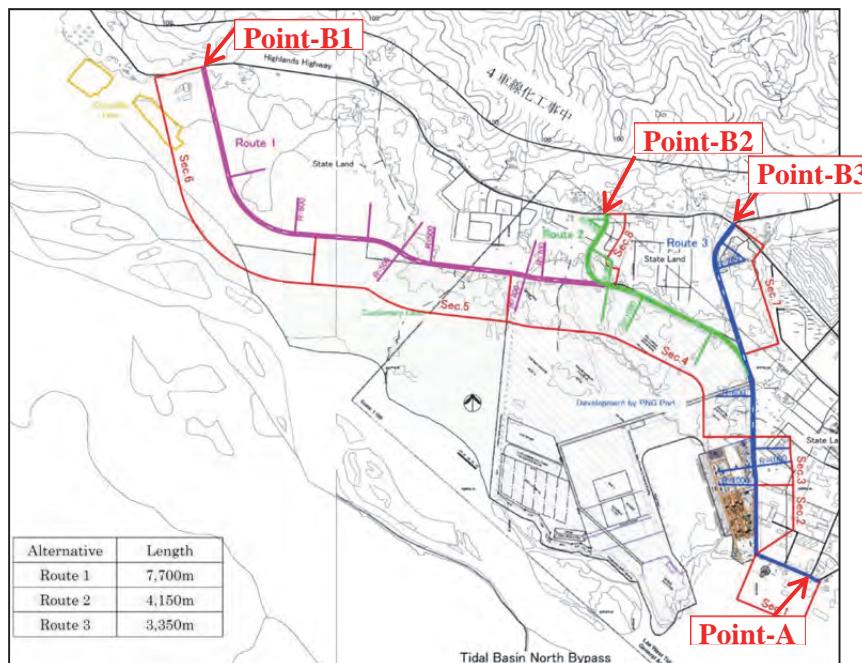
Source: JICA Project Team

Figure 20.1.2 Construction Schedule of Route 2
(24 months)

Description	2019	2020	2021	2022
Construction Period			20 months	
Preparatory Work	■			
Earth Work	■			
Pavement		■		
Road Furniture & Road Markings			■	
Demobilization			■	

Source: JICA Project Team

Figure 20.1.3 Construction Schedule of Route 3
(20 months)



Source: JICA Project Team

Figure 20.1.4 Access Points for Constructions

20.1.2 Access Road

Since the Bypass is new and located in almost vacant land except for the east end part, where the reconstruction of the existing road is planned, access to the construction is easy. Both ends of each route can be the access points as shown in Figure 20.1.4.

20.2 Equipment and Materials Procurement Plan

(1) Fill Material

Since the quality of fill material for the earth work should be high, it is assumed that it will be purchased. However, if dredged soil of the tidal basin is available and suitable for the earth work, the cost would be reduced. In such case, it is necessary to coordinate the construction schedule with PNG Ports and confirm the suitability of the fill material.

(2) Clearing and Grubbing

Disposal of materials generated from clearing and grubbing is assumed to be as follows:

- Topsoil: to be utilize for surface soil of slope
- Logged trees: to be utilized as domestic fuel
- Grubbed stump: to be utilized as fertilizer after chipping

(3) Concrete and Asphalt

There are four (4) major companies in Lae City, supplying concrete, crushed stones and asphalt. Cement clinker producing cement from imported raw materials is also available in Lae City. Straight asphalt and asphalt emulsion are imported.

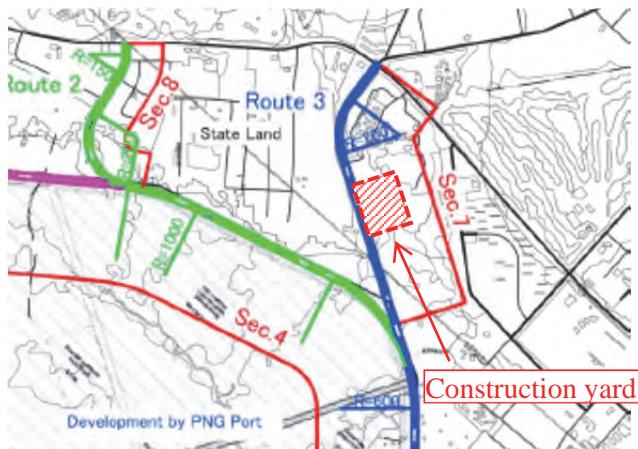
Table 20.1.1 List of Suppliers

Supplier Name	Holding Facilities
Shorncliffe PNG Ltd	Concrete batching plant, Asphalt plant, Crushing plant
JV PNG Investment Ltd	Concrete batching plant, Asphalt plant, Crushing plant
Dekenai Construction Ltd	Concrete batching plant, Crushing plant
Ready Mixed Concrete PNG Ltd	Concrete batching plant, Crushing plant

Source: JICA Project Team

(4) Establishment of Construction Yard

Construction yard is assumed to be located in the site shown in Figure 20.2.1. Even if this location is not available, still there are several other places available around the construction site that can be used as construction yard.



Source: JICA Project Team

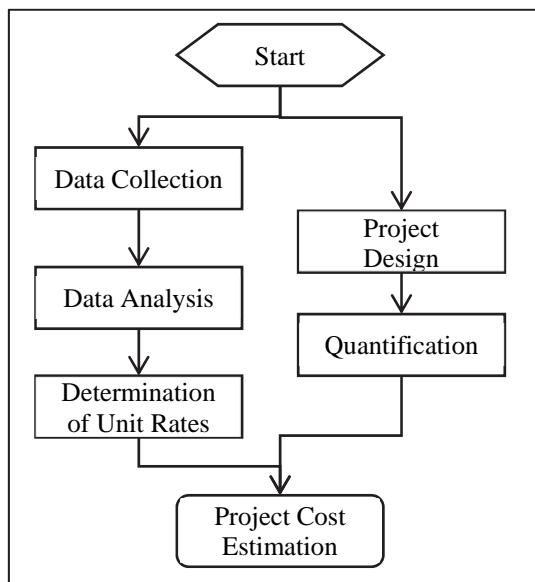
Figure 20.2.1 Candidate Site for Construction Yard

CHAPTER 21 PROJECT COST

21.1 Cost Elements

21.1.1 Study for Cost Estimation

In order to estimate the costs of the project proposed for the Tidal Basin North Bypass, a study was carried out in the follow manner:



Source: JICA Project Team

Figure 21.1.1 Procedure of Cost Estimation

21.1.2 Data Collection

Although effort was made to collect as many data as possible, the collected data were limited. The collected materials are summarized in Table 21.1.1

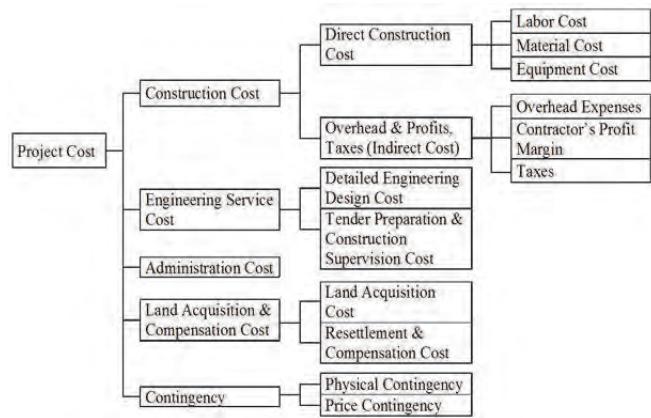
Table 21.1.1 Materials Collected for Cost Estimation

No.	Materials	Source
Documents for Estimation		
1	BOQ of Tidal Basin North Bypass	DOW
2	BOQ of Highlands Highway Reconstruction and Upgrading Project	DOW
3	Unit Costs in Lae city	Local Contractors
4	Material Cost and Machinery Hire in Port Moresby	Local Contractors
5	Construction & Material Costs in Japan 2015	CPC
Reference Documents		
1	Specification for Road and Bridge Works (June 2015)	DOW
2	Standard Engineering Drawings, Road Drawings	DOW
3	Employment Law	Internet
Abbreviation:		
DOW: Department of Works		
CPC: Construction Prices Committee in Japan		

21.1.3 Data Analysis

(1) Composition of Project Cost

In general, a project cost is composed of the elements shown in Figure 21.1.2 below.



Source: JICA Study team

Figure 21.1.2 Composition of Project Cost

(2) Labor Costs

This project plans to carry out the construction during daytime, and not during nighttime or public holidays.

(3) Material Costs

There is little variation in the material costs, except for the cost of bituminous concrete. Most of the construction materials are locally available.

However, cement, asphalt, steel, street light pole, road marking material, and fuel needed for the construction are imported, and the custom duties are levied on them.

(4) Mobilization Cost

The study team has confirmed that the local contractors have enough machinery for implementing this project. But this comes with a high risk of making the number of the remaining machineries insufficient for other public and private construction works. The situation is similar for the concrete batcher and asphalt plants.

Therefore, the cost of mobilizing construction equipment and machineries from Port Moresby was included in the mobilization cost.

(5) Indirect Cost

It includes overhead and profits.

(6) Land Acquisition and Compensation Cost

Since the Bypass passes through state land, there is no land acquisition cost. The project, however, includes resettlement cost.

(7) Other Costs

- Engineering Cost: 10%
- Administration Cost: 2.5%
- Contingency: 15%
- Tax (GST): 10%

21.2 Project Cost

21.2.1 Summary of Estimated Project Cost

Summary of the estimated cost of the Tidal Basin North Bypass is shown in Table 21.2.1

If an overseas company will carry out the project, then the cost has to be increased by 25% to 30%. The additional cost is for covering office, housing, labor, mobilization and security expenses.

Embankment cost may be reduced by using dredged soil from the Tidal Basin if the construction schedule of the project properly overlaps with that of the Basin. The suitability of the dredged soil, however, should be confirmed in advance.

Table 21.2.1 Project Cost of Tidal Basin North Bypass (Unit: PGK)

Description	Route 1 7.70 km		Route 2 4.15 km		Route 3 3.35 km	
	Amount	%	Amount	%	Amount	%
A Construction cost						
1.General	6,821,235	4.07	4,227,065	5.16	3,639,679	5.18
2.Establishment	11,145,209	6.66	6,802,076	8.31	5,792,919	8.24
3.Clearing and Grubbing	1,737,120	1.04	597,960	0.73	588,720	0.84
4.Earth work	61,773,950	36.89	23,930,188	29.24	22,252,025	31.64
5.Pavement	38,644,375	23.08	20,827,813	25.45	16,812,813	23.91
6. Drainage	21,629,400	12.92	11,604,950	14.18	10,046,900	14.29
7. Road furniture & road markings	25,718,000	15.36	13,861,000	16.93	11,189,000	15.91
a1. Sub-total	167,469,289	100.00	81,851,051	100.00	70,322,056	100.00
a2. Contingency (a1x10 %)	16,746,929		8,185,105		7,032,206	
Total (Construction cost) a1+a2	184,216,217		90,036,156		77,354,261	
B. Engineering Cost						
b1. Engineering Cost (a1x10%)	18,421,622		9,003,616		7,735,426	
b2. Contingency (b1x10 %)	1,842,162		900,362		773,543	
Total (Engineering Cost) b1+b2	20,263,784		9,903,977		8,508,969	
C Administration Cost {(A+B)x2.5 %}	5,112,000		2,498,503		2,146,581	
D Total (A+B+C)	209,592,001		102,438,637		88,009,811	
E Compensation cost	0		0		0.00	
F GST {(A+B)x10 %}	20,448,000		9,994,013		8,586,323	
Project cost	230,040,001		112,432,650		96,596,134	
(Mil. PGK)	230.04		112.43		96.60	
(Mil. JPY) ^{*1}	7,931.78		3,876.68		3,330.63	

Note *1: PGK 1 = JPY 34.48, Average for the three months before June 2016

Source: JICA Project Team

21.3 Operation and Maintenance Cost

The Morobe Provincial Government will be responsible for the operation and maintenance of the road. The maintenance is divided into routine maintenance carried out every year, and periodic repair work maintenance carried out every two or five years. Table 21.13 shows the operation and maintenance cost of the Bypass.

Table 21.3.1 Operation and Maintenance Cost of the Bypass

Description	Operation & maintenance cost (Million PGK)			Ratio to Construction Cost	
	Route 1	Route 2	Route 3	Annual Cost	Cost*
Construction cost	184	90	77	-	-
Routine maintenance	460	225	193	0.25%	-
Repair work	Drainage	every 2 years	552	270	231
	Pavement, Shoulder, Ancillary facilities	every 5 years	1,840	900	770

Note: * Cost for a repair work

Source: JICA Project Team

CHAPTER 22 ECONOMIC AND FINANCIAL ANALYSIS

22.1 Economic Analysis

The analysis is carried out for 3 alternatives separately: Route-1, Route-2, and Route-3.

22.1.1 Preconditions and Assumptions

The preconditions and assumptions are shown below.

Table 22.1.1 Preconditions and Assumptions

Items	Preconditions and Assumptions
1. Base Price	Price of year 2016
2. Per-capita income	<ul style="list-style-type: none"> ➤ HH income / Family size <ul style="list-style-type: none"> - Low and lower middle class: 1,400 PGK - Upper middle and high class: 1,700 PGK ➤ Estimate of per-capita income growth: <ul style="list-style-type: none"> - By applying the growth of national compensation account as described below that is a part of the national accounts (GDP)
3. Tax and duties	<ul style="list-style-type: none"> ➤ General service tax: 10% ➤ Import duties: 10% (cement and asphalt) and 15% (street light pole and the likes)
4. Conversion factor (CF)	<ul style="list-style-type: none"> ➤ Standard CF: 0.90, estimated based on the external trade and custom duties, and also referred to projects of ADB ➤ Shadow wage rate for unskilled labor: 0.76 estimated based on the unemployment data
5. Economic life of assets	35 years
6. Opportunity cost of capital	12%: referring to the ADB projects in PNG.
7. Evaluation time horizon	30 years
8. Salvaged value	The residual value of capital investment costs are salvaged at the 30th year

Source: JICA Project Team

22.1.2 Benefits

The followings 5 kinds of benefit are selected and defined for this cost-benefit analysis accordingly:

- Saving of Passengers' Travel-time Value
- Saving of Truck Cargo-hour Value
- Saving of Truck-Freight-hour Value
- Saving of Vehicle Operation Cost
- Reduction of Repair and Maintenance Cost

(1) Saving of Passengers' Travel-time Value

$$= (\text{Saving of passengers' travel-hours in a year}) \times (\text{Per-capita income/hour for working purpose})$$

Table 22.1.2 Passengers' Travel-hours saved in a year (Unit: 1,000 Passenger-Hours)

Road	Vehicle	2020	2030
Route-1	PMV*	9,086	14,660
	Car	3,471	8,695
Route-2	PMV*	9,239	14,660
	Car	3,620	8,882
Route -3	PMV*	6,566	10,689
	Car	2,687	7,202

* Public Motor Vehicle (public transport mode)

Source: JICA Project Team

Car passengers' income is computed as follows.

Car passengers' income = (1. Car owner's income) + (2. Other passengers' income)
1 = 1.9 times * more than all classes' aggregated average income, PGK 1,685
2 = Lower and lower middle class income as shown in Table 22.1.1.
* Elaborated by JICA Project Team based on the trip survey

(2) Saving of Cargo-hour Value

$$= (\text{Saving of Truck travel-hours in a year}) \times (\text{Cargo price/hour}) \times (\text{Bank interest rate})$$

Table 22.1.3 Truck Travel Hours Saved in a Year
(Unit: 1,000 Hours)

Road	Vehicle	2020	2030
Route-1	Truck	403	675
		451	753
		438	784

Source: JICA Project Team

Table 22.1.4 Estimate of Cargo Value per Hour

1.Cargo price	90,000 PGK/TEU
2. Bank interest rate	6.5% a year ¹⁾ , equivalent to 0.000742% per hour
3. Value per hour	0.67 PGK

Source: 1) business loan of National Development Bank of PNG

(3) Saving of Truck Freight-hour Value

$$= (\text{Saving of Truck travel-hours in a year}) \times (\text{Trips /year}) \times (\text{Heavy truck traffic ratio}) \times (\text{Net profit/trip})$$

(4) Saving of Vehicle Operation Cost

$$= (\text{Vehicle-travel-distance per year}) \times (\text{VOC/km})$$

Table 22.1.5 Vehicle Operation Cost

Items	Particulars	Unit	PMV	Car	Truck	
					Light	Heavy
1.Operation Distance		Km/year	32,850	9,125	16,425	57,600
2.Operation Cost						
1)Remuneration	(1)Driver	PGK/year	23,040	-	23,040	23,040
	(2)Assistance		11,520	-	-	-
	Total		34,560	-	23,040	23,040
2)Repair and Maintenance	(1)Spare parts		9,000	1,500	6,000	20,000
	(2)Tire		4,548	608	3,032	127,008
	(3)Fuel		16.797	2,979	5,999	106,885
	(4)Oil		1,080	142	1,350	10,416
	Total		31,426	5,229	16,381	264,310
3) Insurance			890	590	1,173	1,173
4)Overhead			3,299	-	2,091	14,367
5)Depreciation			18,000	15,000	12,000	40,000
Total			88,875	20,819	57,085	342,890
Operation Cost/vehicle		PGK/km	2.7	2.3	3.5	6.0

Source: Elaborated by JICA Project Team based on the interview and questionnaire to the transport companies

Table 22.1.6 Vehicle -Travel-Distance by year
(Unit: 1000 Vehicle-km)

Road	Vehicle	2020	2030
Route-1	PMV	218	256
	Car	353	658
	Truck	610	845
Route-2	PMV	274	345
	Car	444	877
	Truck	694	996
Route -3	PMV	-3	42
	Car	16	145
	Truck	679	1,045

Source: JICA Project Team

(5) Reduction of Repair and Maintenance Cost

The by-bass road (with-project) will reduce the periodical repair and maintenance cost of Highlands Highway (with-out project), particularly for resurfacing, road shoulder and incidental facilities, by prolonging the maintenance intervals from 5 years to 10 years.

Table 22.1.7 Annualized Reduction of Cost

Item	Unit	Route-1	Route-2	Route-3
Reduction amount in 25 years	PGK million	6.53	2.91	1.76
Annualized reduction amount	PGK million /year	0.26	0.12	0.07

Source: JICA Project Team based on the repair and maintenance cost of the Highlands Highway

22.1.3 Economic Project Cost

The project cost consists of (1) capital investment cost and (2) repair and maintenance (R&M) cost. Price escalation and the taxes such conversion factor as import duties and general service tax (GST) are disregarded in the economic project cost. The local cost is discounted by applying the conversion factor (CF).

Table 22.1.8 Capital Investment Cost
(Unit: PGK million)

Cost	Route	Year 1	Year 2	Year 3	Year 4	Total
Econo- mic cost	Route-1	22.3	73.6	73.6	30.2	199.7
	Route-2	23.1	74.8	-	-	97.9
	Route-3	27.3	56.8	-	-	84.1

Source: JICA Project Team

Table 22.1.9 Repair and Maintenance Cost
(Unit: PGK million)

Cost	Route	Inspect-	Culvert	Resurfacing, etc.
		Ever year	Every 2 years	Every 5 years
Econo- mic cost	Route-1	0.43	0.51	1.71
	Route-2	0.21	0.25	0.83
	Route-3	0.18	0.21	0.72

Source: JICA Project Team

22.1.4 Economic Analysis

(1) Results of Base Case

Economic analysis is conducted based on the above benefit and economic project cost. Table 22.1.9 shows the result of the analysis (for details, see Appendix 11). Route-1 shows comparatively lower EIRR compared to Route-2 and Route-3. Meanwhile, the EIRRs of the Route-2 and Route-3 are larger than 17%; as a result, both Routes are judged to be economically feasible.

Table 22.1.10 Results of Economic Analysis (Base Case)

Route	EIRR	B/C	NPV
Route-1	10.9%	0.86	PGK 16.8 million
Route-2	17.8%	1.76	PGK 49.8 million
Route-3	17.0%	1.62	PGK 35.7 million

Source: JICA Project Team

Table 22.1.11 Results of Sensitivity Analysis of Route-3

Scenario		EIRR	B/C	NPV
Scenario-1	With decrease of capital inv. costs: 60%	12.2%	1.0	PGK 1.7 million
Scenerio-2	With decrease of traffic demand: 20%	15.8%	1.5	PGK 5.4 million

Source: JICA Project Team

The following conclusions can be reached based on the sensitivity analysis:

- The base case of the both Route-2 and Route-3 is economically feasible showing an EIRR higher than 12% as presented in Table 22.1.9.
- Even after an increase of the capital investment cost by 60% (scenario 1), the projects remain economically feasible.
- Decreasing traffic demand by 20% (scenario 2) reduces the EIRR; however, the project still remain economically feasible.
- In case of 15% reduction of the capital investment cost or 20% increase in traffic demand, Route-1 turns to be feasible.

22.1.5 Qualitative Benefits

The implementation of this project will have various social and economic effects as assumed. However, these effects can be hardly evaluated quantitatively, *i.e.*, converted into a monetary value. To evaluate the project comprehensively, it is necessary to take into consideration these qualitative benefits.

22.2 Financial Analysis

As presented in Table 22.1.9, the capital investment costs of the project is summarized as follows:

- Route-1: PGK 245.6 million
- Route-2: PGK 120.0 million
- Route-3: PGK 103.1 million

These costs are extremely larger than the capital expenditure budget of the Morobe Provincial Government which was only 129 million PGK in 2016 (see Table 13.2.3); consequently, for the implementation of the project, the capital investment costs should be shared with or granted by the Central Government or the donors.

CHAPTER 23 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

After comparison of the three alternative routes of the bypass from viewpoints of social impacts, technical standards and fund raising, in addition to the economic analysis, Route 3 is considered to be most feasible. Environmental and social considerations are conducted focusing on Route 3.

23.1 Environmental and Social Considerations

The proposed Bypass Project is connecting Lae Port to the Highlands Highway. The bypass will be 3.35 km long and 15 m wide. The bypass will be at 1.5 m above the ground level taking account of the floods. Side ditches are applied at both sides of the bypass, and pipe culverts across the bypass will be installed at 100 m intervals.

Whether the proposed Bypass Project requires EIA or not must be confirmed with CEPA during environmental approval process. The Provincial Planner under the Cooperate Governance and Management of the Morobe Provincial Government is the responsible body for environmental and social considerations of projects.

Alternative analysis including “without project” option was conducted in terms of environmental, social, technical and financial aspects. The selected option has the least social impact among the three alternative routes.

Preliminary Scoping was carried out based on a possible case as result of the implementation of the proposed Bypass Project. Based on the preliminary scoping, a draft TOR was formulated in case the project will be subject to EIA. EIA should be carried out in adherence to the relevant legislations of PNG and the JICA Guidelines for Environmental and Social Considerations (2010).

Table 23.1.1 Preliminary Scoping (Summary)

Items	Anticipated Impact
Involuntary Resettlement	Relocation of few structures, trees, crops may be triggered. Further investigation is needed to confirm if resettlement will be triggered.
Living and Livelihood	Changes in living and livelihood of the project affected households to be resettlement may be triggered. Further

Items	Anticipated Impact
	investigation is needed to confirm if resettlement will be triggered. Construction of a new bypass is expected to bring positive impacts, such as better transportation and an alternative route in case of emergencies.
Utilization of Land and Local Resources	Construction of the new bypass will alter the land use within the route. Presence of the new bypass is expected to improve local land and resource use.
Existing Social Infrastructures and Services	During planning and construction stage, the existing infrastructures such as the high school, the Highlands Highway, nearby residential areas may be affected by construction activities. Construction of the new bypass is expected to bring positive impacts, such as better transportation and an alternative route in case of emergencies.
Ethnic Minorities, Indigenous Peoples, Gender and Children's Rights	Project Affected Households may include women headed households or vulnerable groups. Further investigation is needed to confirm the presence of such households. During construction stage, there may be gender inequality of employment or risk of employing children.
Public Health	During construction stage, public health may be affected if proper sanitation facilities are not in place at the construction site.
Infectious Diseases (AIDS/HIV)	During construction stage, the risk of occurrence or expansion of infectious diseases will increase because of influx of workers unless proper preventative measures are in place.
Working Environment	During construction stage, working environment may become poor if appropriate measures are not in place.
Topography and Geology	During construction stage, building embankment using about 130,000 m ³ of earth will causes changes in topography, although minor.
Hydrology	During construction stage, building embankment will causes changes in draining pattern in the area, although it is unknown at this stage. During operation, the area may be flooded if proper drainage system is not in place..
Ecosystem	Although the existing data indicates that there is no rare/important species in the area, further investigation is needed to confirm.
Air Quality	During construction stage, emission of air pollutants by vehicles and machines will occur, although it can be mitigated and temporary.

Items	Anticipated Impact
Water Quality	During construction stage, emission of water pollutants by construction activities and presence of workers will occur, although it can be mitigated and temporary. Slope of the embankment will be covered with vegetation to prevent soil runoff.
Wastes	During construction stage, waste may be generated by construction activities and presence of workers, although it can be mitigated and temporary.
Noise and Vibration	During construction stage, noise will be generated by construction activities and operation of vehicles and machines, although it can be mitigated and temporary. During operation stage, the traffic on the new bypass road will cause noise.
Subsidence	Since the land of the proposed project site is expected to be soft, subsidence may occur. Further investigation is needed to confirm.
Accident	During construction stage, accidents may happen. During operation stage, road accidents may occur on the new bypass road.

Source: JICA Project Team

The result of the preliminary scoping indicates that impacts by the proposed project will be mainly due to construction activities and limited to the site. Therefore, mitigation measures generally used for road construction projects may be applicable.

Mitigation measures and monitoring plan will be formulated during environmental approval process as required. Stakeholder meetings will be carried out during environmental approval process and preparation of resettlement plan, once the details of the project are fixed and the actual project scope is determined.

23.2 Land Acquisition and Resettlement

The proposed Bypass Project passes state land; hence, land acquisition is not required. However, it is advisable to obtain an authorization on the Project plan by the relevant authorities for smooth implementation of the Project.

The Project site runs along the boundary of the Lae Tidal Basin Project, supported by ADB. Within the proposed Bypass route, there are two to three houses and they may be avoided by adjusting the route alignment. Compensation for trees and crops within the proposed route may be needed.

In PNG, there is no legislation stipulating preparation of Resettlement Action Plan. In case

the project triggers resettlement, an Abbreviated Resettlement Action Plan (ARAP) will be prepared in accordance with the legislation of PNG and the JICA Guidelines. Since the Lae Tidal Basin Project site is adjacent to the proposed Bypass route, the Resettlement Action Plan for the Lae Tidal Basin Project should be referred.

The key authority for land management and relevant issues in the area is Department of Lands and Physical Planning of Momase Regional Office.

The proposed Bypass road is estimated to be 3.35 km long. The width of the proposed Bypass road should be about 25 m including the embankment and side ditches on the both sides; hence, a right-of-way of at least at least 25 m, and up to 40 m wherever possible by taking future expansion into consideration, will be secured.

Entitlement and conditions for compensations and grievance mechanism should be in line with those of the RAP for the Lae Port Project as much as possible, in order to keep the equality among the people affected by these projects.

The proponent of the proposed Project, the Morobe Provincial Government, is most likely to be the organization responsible for securing costs for the Project and implementing and monitoring the ARAP. This will be confirmed once Project Management Unit is established for the Project

Meetings with Project Affected Persons will be held during preparation of the ARAP in order to explain about the purpose of the Project and scope of resettlement, and to build consensus on entitlement and policies of compensation, etc. The records of meetings will be attached to the ARAP.