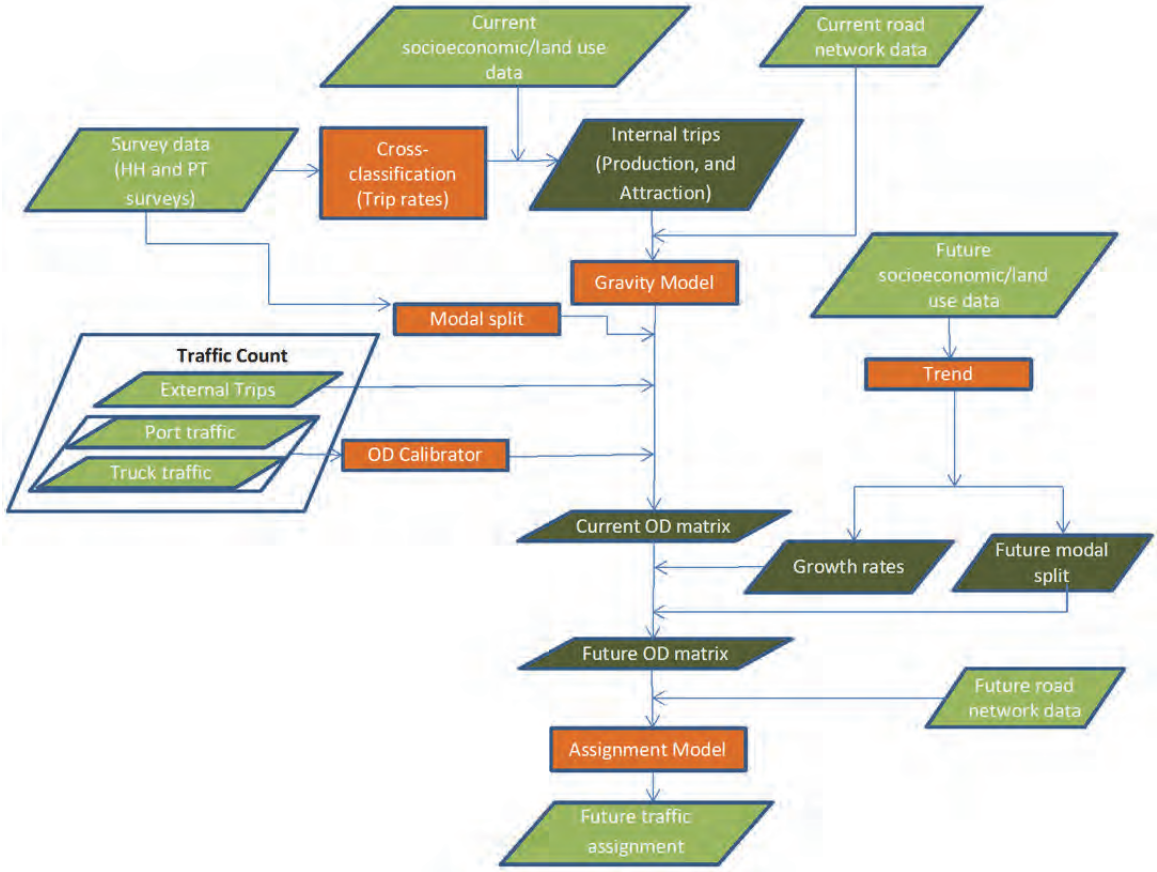
CHAPTER 12 INFRASTRUCTURE AND SERVICES PLAN (Sectoral)

Spatial and economic development master plans prepared in the previous Chapter 11 are the foundation of infrastructure and social service development projects. In this chapter, the Project target sector sub-projects are proposed based on the sector based current infrastructure and social service status studies illustrated in Chapter 6 of the Report. In particular, transportation sector, water supply sector, sanitation & sewage sector, waste management sector, storm water & drainage sector and social service sector (mainly education and healthcare) are discussed, and power supply sector and telecommunication sector possibilities are indicated. Each of these sub-projects is proposed in order to maximize positive impact to the regional economic development as well as spatial development in the Project Area. Current economic activities and market conditions in the region are taken into consideration with the economic development master plan in order to properly identify local needs of infrastructure and social services. The development of industry to improve economic activities in the region becomes the key to change such livelihood in Lae-Nadzab Area with stable job creation, and proposed infrastructure sub-projects will be so arranged to maximize the integration with economic development.

12.1 Land Transport

12.1.1 Travel Demand Forecasting

Figure 12.1.1 shows the flowchart of the travel demand forecasting process of the Project Area. 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. The analysis was conducted using JICA STRADA



Source: JICA Project Team

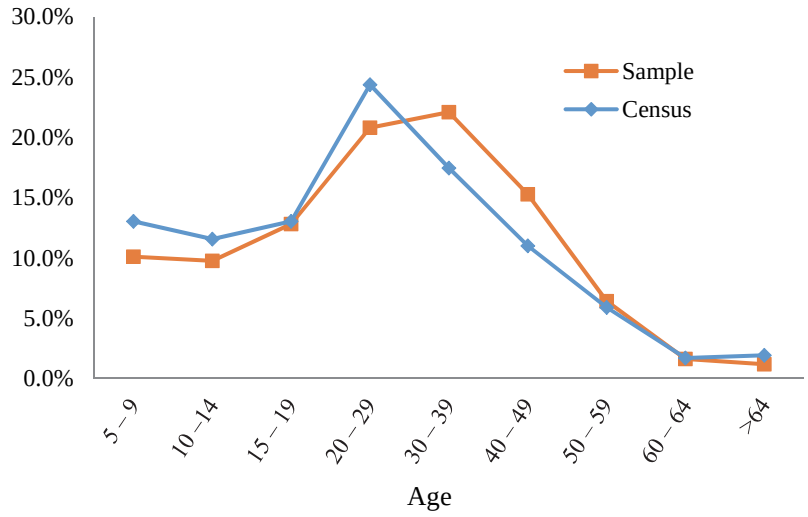
Figure 12.1.1 Traffic Demand Forecasting Process

(1) Trip Generation

Cross-classification (category analysis) method was used to estimate the trip production and trip

attraction rates. The person trip data were categorized by area (urban and rural) and vehicle ownership expecting different trip patterns. Although the average trip production rates were as expected slightly different by vehicle ownership (higher for those who belong to household with at least one vehicle), no significant differences by area were observed.

The average daily person trip production rate obtained from the data was about 1.6 per person, a rate significantly lower than that of similar Asian cities. The data were analysed for any bias, or under reporting that resulted in the lower trip production rate. As Figure 12.1.2 shows, there are only minor discrepancies between the sample and the census distributions on age. It was, however, found that most of the students (about 60%) have not reported any trip at all. About 36% of the employees have also not reported any work related trip or trip at all. The trip rates of both urban and rural areas were corrected for the indicated underreported trips. After adjusting for the under-reporting, the average daily trip rate increased to two trips per person for both urban and rural areas.



Source: JICA Project Team

Figure 12.1.2 Age Distribution

(2) External and Truck Trips

Since the person trip survey does not fully grasp the external trips (i.e., trips with at least one end outside the Project Area), traffic count and roadside interview surveys at external cordons were used to estimate them. Similarly, the truck trips were also estimated based on the traffic count and roadside interview surveys. To avoid double counting, external (passenger vehicle) and truck trips were excluded from the person trips survey.

(3) Future Trips

Future trips were estimated based on the expected socioeconomic and land use development. Future truck trips were estimated based on the annual growth rate of the port freight, and the external person trips based on the population growth rate.

(4) 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.

(5) Modal Split

Currently, the modal share is dominated by public motor vehicles (PMV), accounting for 75% of the motorized trips (excluding trucks), while cars account for just 25%. The economic growth and subsequent motorization is expected to shift the current modal split. An extreme future scenario in which the PMV share shrinks to 40% and that of the car increases to 60% is considered. The current

vehicle occupancies of 4.26 and 17.43 of cars and PMVs, respectively, are assumed to remain constant.

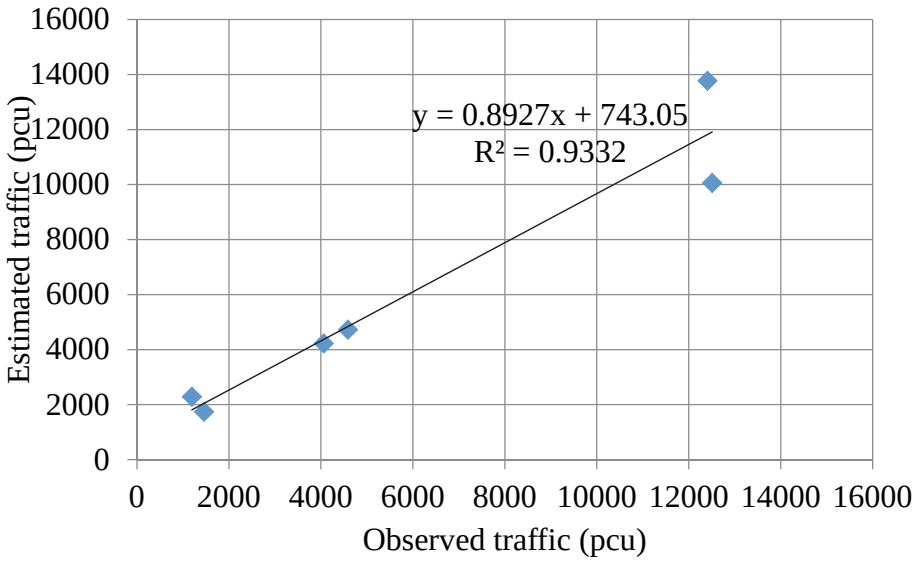
(6) Traffic Assignment

Different scenarios were considered in the 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 analysed. 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 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, as Figure 12.1.3 confirms. The model is good and has R-squared of 0.93, as Figure 12.1.4 of the plot of observed and estimated link flow shows.

Source: JICA Project Team

Figure 12.1.3 Base Case Traffic Assignment (2015)



Source: JICA Project Team

Figure 12.1.4 Observed versus Modelled Link Flows

Major bottlenecks, however, will appear in the future if the network remains as it is, as Figure 12.1.5 of the do-minimum case shows. In this case, the traffic flow crossing Bumbu River will be severely impeded as the existing two bridges will be over capacity (VCR of North Bumbu Bridge will be 2.1, and that of South Bumbu Bridge will be 1.7). In fact, as Figure 12.1.3 of the base condition shows that the North Bumbu Bridge and approaching road sections are already congested and this was confirmed by a filed visit (Figure 12.1.6). Therefore, as the congestion would get worse with the traffic growth, it is imperative to take appropriate measures to avoid this scenario.

Source: JICA Project Team

Figure 12.1.5 Do-minimum Case Traffic Assignment (2025)

Source: JICA Project Team

Figure 12.1.6 Traffic Approaching North Bumbu Bridge in the Afternoon Peak

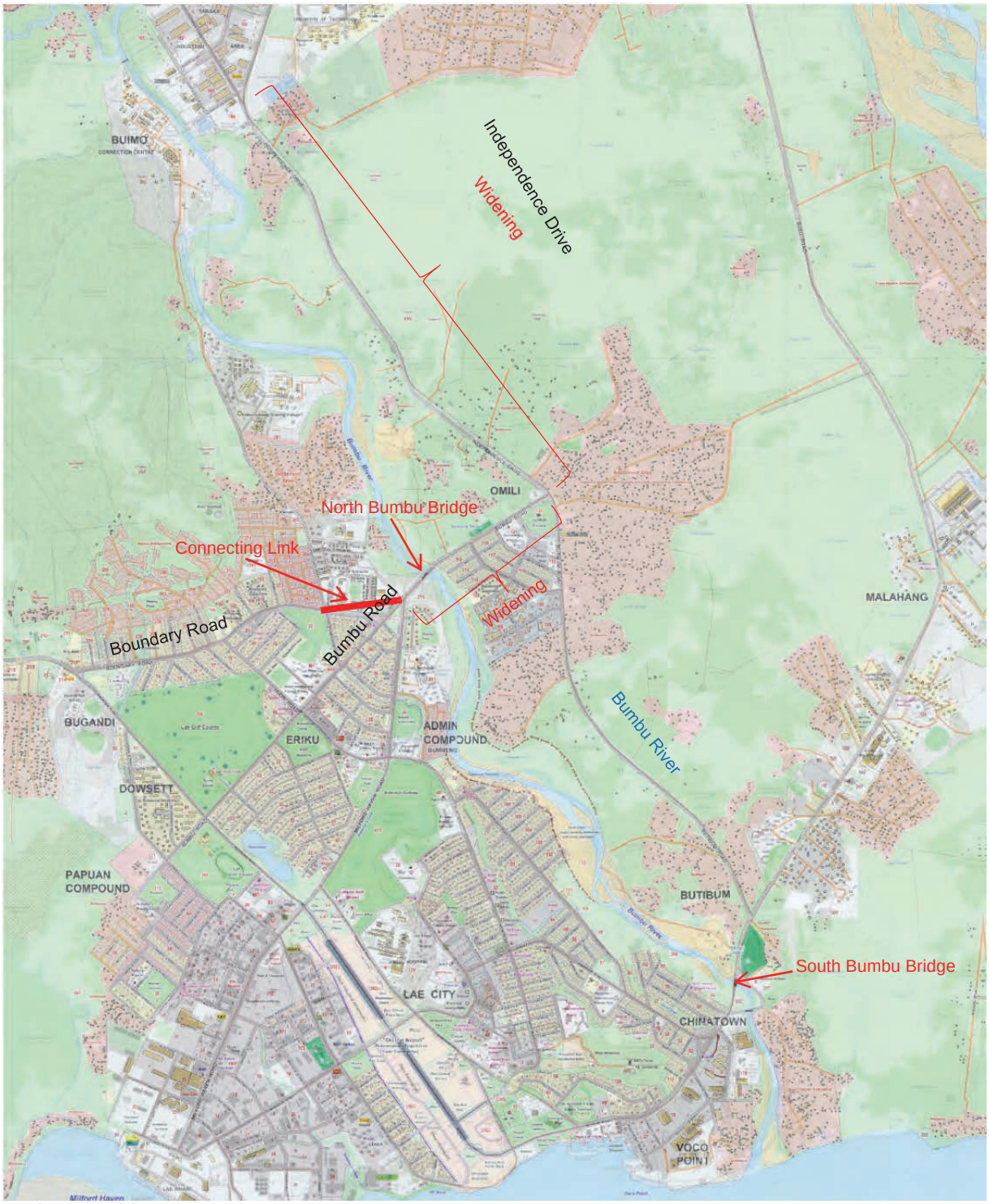
12.1.2 Future Traffic and Network

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

(1) Relieving bottlenecks

As already mentioned, one of the most compelling issues that should be addressed is the traffic flow crossing Bumbu River, as the capacity of the two bridges will be far lower than the expected traffic by 2025. One way of solving this issue could be widening the existing bridges and related roads. Another way could be developing the additional one or two bridges, however, Bumbu River is considerably wide excepting the sections where existing bridges are located at. Although more specific analysis is required to compare alternative options, the first case could be easy way. However, once the North Bumbu Bridge is widened into four lanes, some amount of the traffic passing through the South Bumbu Bridge will shift to the North, and the related sections of Bumbu Road and Independence Drive will be also over capacity.

As a result, the Study proposed to widen the section of Independence Drive and Bumbu Road including the North Bumbu Bridge, into four lanes, as shown in Figure 12.1.7.



Source: JICA Project Team

Figure 12.1.7 Relieving Bottleneck around Bumbu River

Moreover, the two more bottlenecks are observed at Markham Bridge and the Busu Bridge & its 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

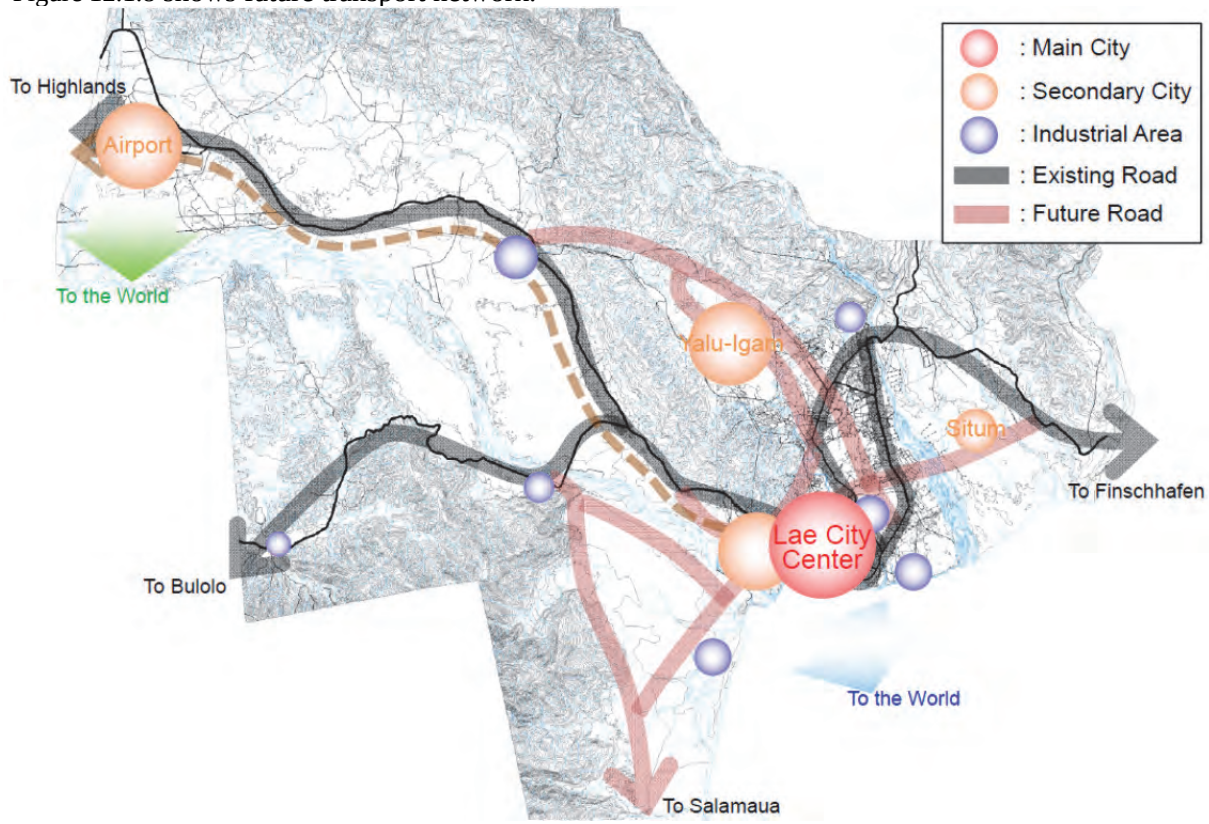
Taking account of the existing major road network, topography, major cities, industrial hubs and proposed development areas, the following new major roads are proposed in order to mainly improve the level of service.

1) Construction of Yalu-Igam Highway
2) Construction of Bypass Highway behind Lae Tidal Basin
3) Construction of collector roads between Independence Drive and Busu Road
4) Construction of Nadzab Airport City Road and Erap Bridge

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

1) Rehabilitation of Lae City roads
2) Rehabilitation of two access roads to Labu area
3) Construction of two bridges and some box culverts along Bukawa Road
4) Technical Assistance for Road Maintenance in Lae City

Figure 12.1.8 shows future transport network.



Source: JICA Project Team

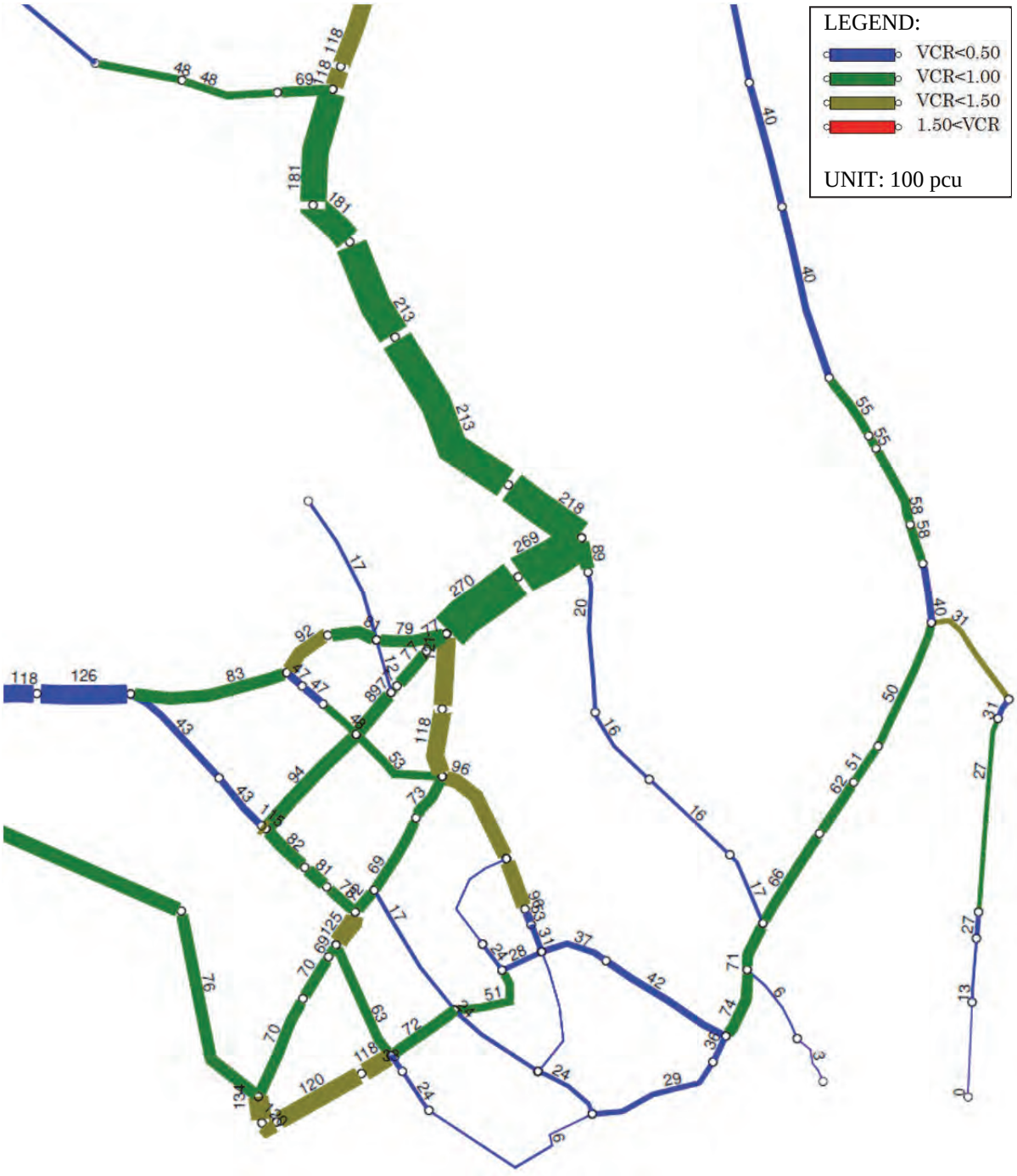
Figure 12.1.8 Future Transport Network

(3) Traffic assignment on proposed future road network

Traffic analysis was conducted by including the roads (bridges) critical for relieving the bottlenecks and the main roads proposed for improving the level of service, as a do-something case. Figure 12.1.9 and Figure 12.1.10 show the result of the traffic assignment of this case.

Source: JICA Project Team

Figure 12.1.9 Do-something Case Traffic Assignment (2025)



Source: JICA Project Team

Figure 12.1.10 Do-something Case Traffic Assignment (2025) Central Area in Close-up

12.1.3 Public Transport Plan

The two out of three main PMV terminals located in Lae City, which are located in the Main Market and Eriku, do not have enough space for the operations and are causing traffic jams around them, and therefore, their improvement are urgently required. Furthermore, new PMV terminal is required in the Airport City, and it will work as hub terminal between urban routes and rural routes (long-distance routes).
On the other hand, the problem of PMVs is caused by not only their poor facilities but also lack of a proper management system. Therefore, it is required to establish new organization in charge of public transport management.
There is also the demand for long distance freight and passenger transport between Highland area and Lae. For a long-term perspective, the railway could be an alternative to the highway, and its feasibility study will be required.

12.1.4 Road Greening

As part of the garden city, roads should be greened as far as the space is available. Figure 12.1.11 shows examples of greening.

Figure 12.1.11 Examples of Road Greening

12.1.5 Land Transport Projects

Major projects for the land transport sector targeted up to 2025 are summarized below.

Table 12.1.1 Land Transport Projects

No	Project Title	Project Outline	Proposed Location
TR-1	Widening of North Bumbu Bridge and related roads	To relieve the bottlenecks of two Bumbu Bridges, the North Bumbu Bridge and related roads are to be widened into four lanes. At same time, existing two lane North Bumbu Bridge is also to be reconstructed as it has serious damage.	North Bumbu Bridge
TR-2	Widening of Independence Drive	As soon as the Project TR-1 is implemented, Independence Drive should be widened into four lanes between Taraka and Omeli roundabout in order to accommodate the traffic to be increased by the Project.	Independence Drive
TR-3	Widening of Markham Bridge	This is the Project to construct one more single-lane bridge parallel to existing Markham Bridge. The existing bridge has only single lane with width of 3.5 m, and is operating as one way alternating traffic. It is expected to be choked up in near future.	Markham Bridge

TR-4	Widening of Bukawa Road	This is the Project to widen the single lane section of the Bukawa Road which is located between Bumayong Intersection and POM Bridge into two lanes. This is including the widening of Busu Bridge and Pom Bridge.	One lane section of Bukawa Road
TR-5	Signalization of intersections in Lae City	This is the Project to convert roundabouts or uncontrolled intersections into signalized intersections. According to the traffic analysis for 2025, ten intersections in Lae City will exceed their capacities and they are required to be signalized.	Lae City
TR-6	Construction of Yalu-Igam Highway	This is the Project for constructing new highway connecting Igam road to the Highlands Highway at Yalu area. The new highway is expected to function as an alternative road to the Highlands Highway to exclude through traffic between the east and the west from Lae City centre. Moreover, the development of new Garden City is proposed along this highway.	Area between Yalu and Igam
TR-7	Construction of Bypass Highway behind Lae Tidal Basin	This is the Project for constructing new bypass highway connecting Lae Port to the Highlands Highway at 6 Mile. This new highway will function as an alternative road to the Highlands Highway to exclude through traffic between Lae Port and Nadzab or Highland area from Lae City.	Area behind Lae Tidal Basin and between Highlands Highway and Markham River
TR-8	Construction of collector roads between Independence Drive and Busu Road	This is the Project for construction of new collector roads in the Ahi Rural Kamkumun area enclosed by Independence Drive, Busu Road and Telkom Road. This area has currently large open space excepting some informal settlements, and has hardly any road network. As it is close to Lae central area, it has the potential of big expansion of the settlement. Therefore, the collector road network should be developed in this area before the settlement is expanded.	Ahi Rural Kamkumun Area enclosed by Independence Drive, Busu Road and Telkom Road
TR-9	Rehabilitation of Lae City Roads	DOW has made a rapid progress in Lae City Roads Rehabilitation, and it is still on progress. However there are some deteriorated roads observed and they required to be rehabilitated.	Lae City
TR-10	Rehabilitation of two access roads to Labu areas	This is the Project to rehabilitate two access roads in Labu area. One is to connect Markham Bridge and Labu 1 along Markham River, another one is to connect from Markham Bridge toward the south along the foot of mountain. Labu area has three villages, but all of them do not have land access route to Lae City and they are constrained to use boat.	Labu area
TR-11	Construction of PMV Terminals	There are three main bus terminals in Lae City, which are in Top Town, Main Market and Eriku. The Top Town terminal has a capacity to accommodate the current traffic of PMVs, but the other two terminals do not have enough spaces and are causing traffic jams. Therefore, it is urgently required to improve these two terminals in Main Market and Eriku. Moreover, new PMV terminal is required in the Airport City, and it will work as hub terminal between urban routes and rural routes (long-distance routes).	Main Market area, Eriku area and Airport City
TR-12	Feasibility Study for Railway between Highland area and Lae Port	Since there is the demand for long distance freight and passenger transport between Highland area and Lae, the railway could be an alternative to the highway. It is required to conduct feasibility studies.	Between Lae and Mount Hagen
TR-13	Technical Assistance for PMV Management	Since there is no control over PMV operations, traffic congestion occurs frequently around the terminals and the operations are not well organized. Therefore, it is required to establish an organization in charge of PMV management under MPA and provide a technical assistance to them.	—
TR-14	Technical Assistance for Road Maintenance	Since there is no enough maintenance provided by LULLG who are supposed to maintain the most of the roads in Lae City, road conditions in Lae City are very poor. Therefore it is required to provide a technical assistance regarding road maintenance to LULLG.	—

Figure 12.1.12 shows the locations of proposed projects listed above.

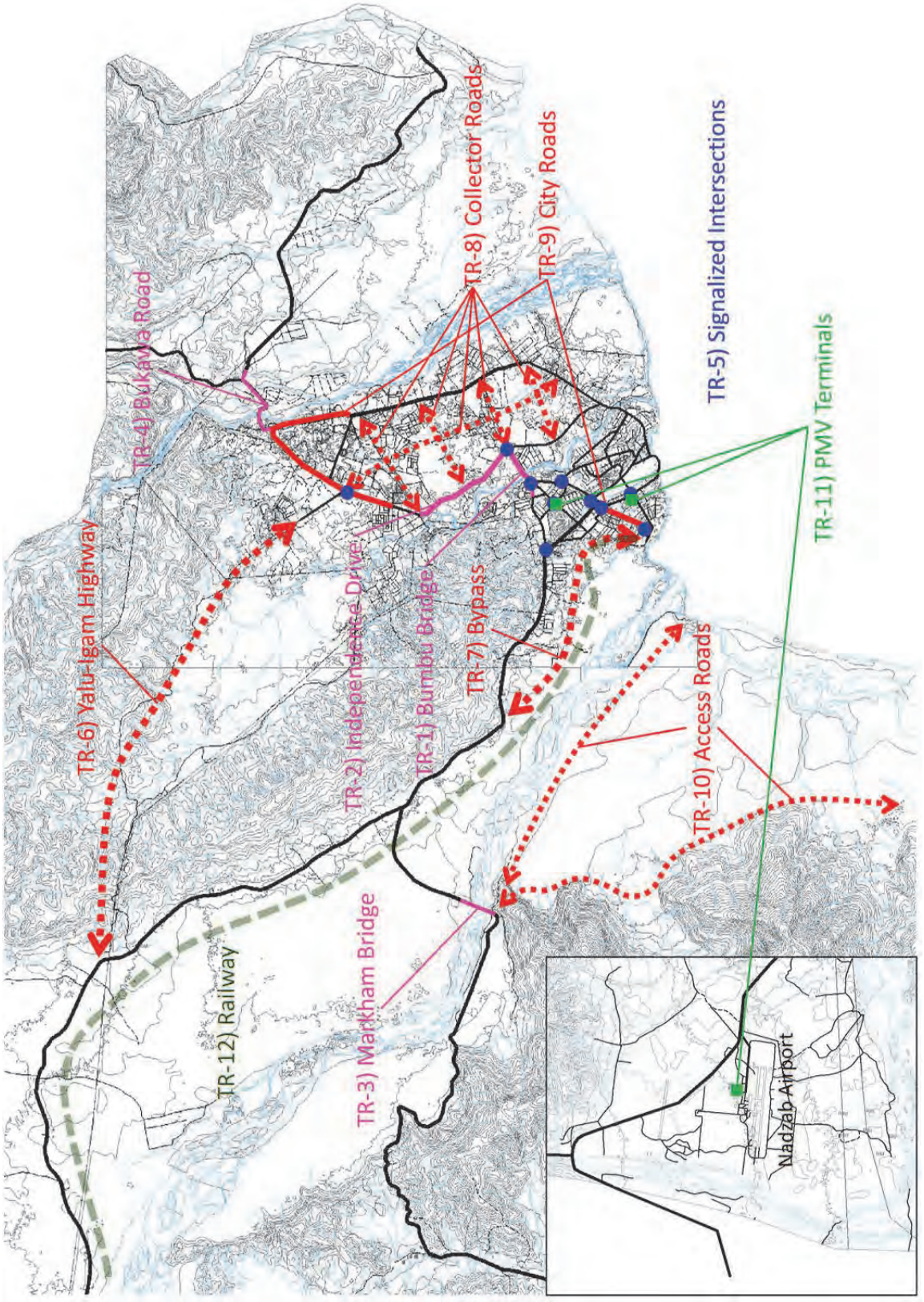


Figure 12.1.12 Location of Proposed Land Transport Projects

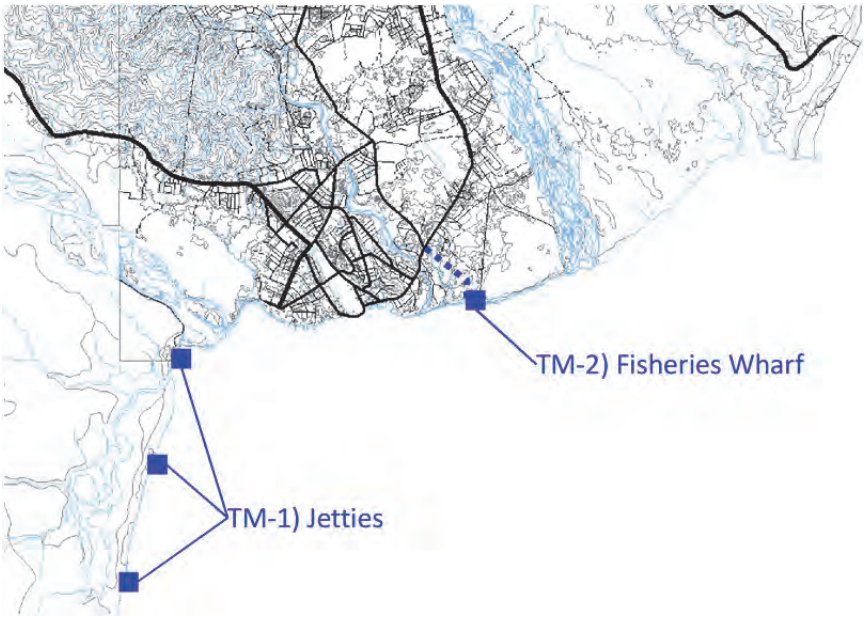
12.2 Maritime Transport

12.2.1 Maritime Transport Plan

As explained in Chapter 6.2.1, the major maritime cargo transport was planned by PNG Ports Corporation and the expansion of Lae Port is on-going under the support by ADB.
Taking account of existing conditions, the following two projects targeted up to 2025 are proposed.

Table 12.2.1 Maritime Transport Projects

No	Project Title	Project Outline	Proposed Location
TM-1	Construction of Jetties for Labu	The boat transportation is the only way to access Lae City from Labu area. However, there are no jetties on the Labu side, and it is difficult to approach the sandy coast by the boat during tidal waves. Therefore, construction of three jetties for each Labu village is required.	Labu area
TM-2	Development of Fisheries Wharf in Wagang	This fisheries wharf development is being planned by Morobe Provincial Administration in cooperation with National Fisheries Authority since 2009 due to the fact that Lae main port is congested with vessels. The wharf will be developed together with fish processing industrial park.	Wagang area



Source: JICA Project Team

Figure 12.2.1 Location of Proposed Maritime Transport Projects

12.3 Air Transport

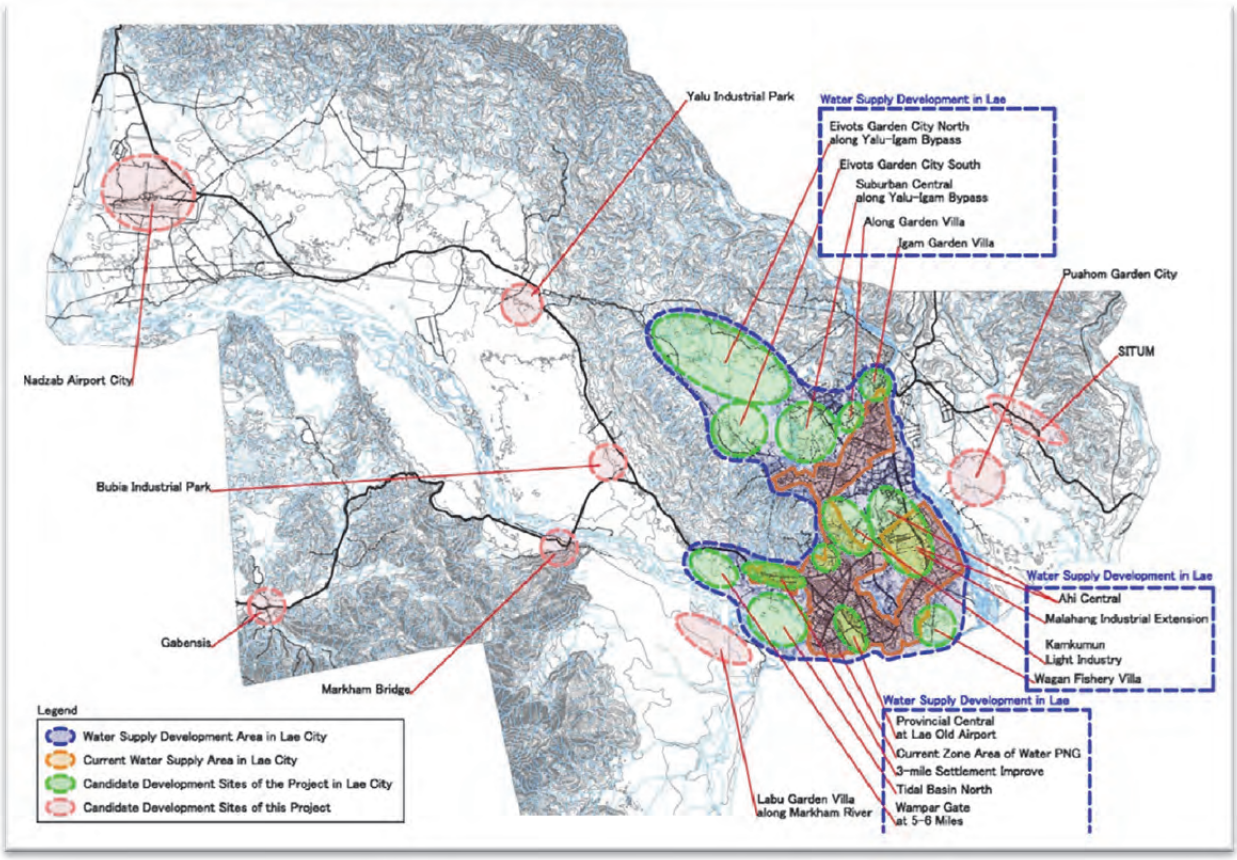
12.3.1 Air Transport Plan

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 under the Project shall basically be the aforementioned 22 sites. The target area and sites for Water Supply Development are as shown below.



Source: JICA Project Team

Figure 12.4.1 Target Area for Water Supply Development

In the Water Supply Development, 14 sites (green hatching sites), of the total 22, are planned as expansion of the current water supply area (orange hatching area) managed by Water PNG, named "Water Supply Development in Lae" (blue hatching area). Therefore, in this Project, these 14 sites are not planned individually but these sites are included in the improvement plan of existing water supply facilities. Meanwhile, the other eight sites (pink hatching sites) are planned individually. Yalu Village and Labu Village adjoin the "Yalu Industrial Park" and "Labu Garden Villa along Markham River" development sites. Therefore, in this Project, development of Yalu Village and Labu Village is also considered.

12.4.2 Urban Development Plan of Target Sites for Water Supply

(1) Population Projection of Target Sites

From the development plan of this Project, the current (2015) and projected (2025, 2050)

Table 12.4.1 Current and Projected Population of Target Sites (2015, 2025, 2050)

Project Title	Location			Zone (Water PNG)	Population							Remarks
					Population in Existing Areas			Poulation in New Development Areas		Future Population in Target Area		
	LLG	Ward			Current	Projection						
		No.	Name		2015	2025	2050	2025	2050	2025	2050	
Water Supply Development in Lae	Lae Urban	1	ERIKU/BUNDI	Zone01	3490	3518	4076	0	0	3518	4076	
				Zone03	9272	9349	10831	0	0	9349	10831	
				Zone04	1821	1835	2127	0	0	1835	2127	Rehabilitation and Function Enhancement
				Zone05	953	960	1113	0	0	960	1113	
				Zone06	2900	2923	3387	0	0	2923	3387	
				Zone20	3617	3645	4224	0	0	3645	4224	
				Zone21	3237	3263	3781	2000	2000	5263	5781	Buimo Garden Villa
				Zone22	2951	2974	3446	0	0	2974	3446	Rehabilitation and Function Enhancement
				Sub Total (A)	28241	28467	32985	2000	2000	30467	34985	
		2	TOP TOWN	Zone14	219	221	256	0	0	221	256	Rehabilitation and Function Enhancement
				Zone15	8	8	10	2000	5000	2008	5010	Provincial Central at Lae Old Airport
				Zone16	1685	1699	1968	0	0	1699	1968	
				Zone17	2587	2607	3021	0	0	2607	3021	Rehabilitation and Function Enhancement
				Zone18	2806	2828	3277	0	0	2828	3277	
				Zone19	3952	3984	4616	0	0	3984	4616	
				Sub Total (B)	11257	11347	13148	2000	5000	13347	18148	
		3	MAIN MARKET	Zone07	1536	1548	1794	0	0	1548	1794	
				Zone08	5116	5158	5975	0	0	5158	5975	
				Zone09	37	37	43	0	0	37	43	Rehabilitation and Function Enhancement
				Zone10	99	100	116	0	0	100	116	
				Zone11	161	162	188	0	0	162	188	
				Zone12	1313	1323	1534	0	0	1323	1534	
				Zone13	929	936	1085	0	0	936	1085	
				---				3000	13000	3000	13000	Tidal Basin North
				Sub Total (C)	9191	9264	10735	3000	13000	12264	23735	
		4	HAIKOST	Zone23	5518	5562	6445	0	0	5562	6445	Rehabilitation and Function Enhancement
				Zone24	4512	4548	5270	0	0	4548	5270	
				Zone25	3782	3812	4417	0	0	3812	4417	3-mile Settlement Improve
				Sub Total (D)	13812	13922	16132	0	0	13922	16132	
		5	UNITECH	Zone28	13707	13933	13933	0	0	13933	13933	Rehabilitation and Function Enhancement
				Zone32	2482	2522	2522	0	0	2522	2522	
				Sub Total (E)	16189	16455	16455	0	0	16455	16455	
		6A	EAST TARAKA	Zone26	4452	4525	4525	0	0	4525	4525	Rehabilitation and Function Enhancement
				Zone30	221	225	225	0	0	225	225	
				Sub Total (F)	4673	4750	4750	0	0	4750	4750	
		6B	WEST TARAKA	Zone27	4272	4343	4343	0	0	4343	4343	Rehabilitation and Function Enhancement
				Zone31	3150	3201	3201	0	0	3201	3201	
				Sub Total (G)	7422	7544	7544	0	0	7544	7544	
		6C	IGAM	---	2215	2251	2251	5000	18000	7251	20251	Igam Garden Villa Abong Garden Villa Suburban Central along Yalu-Igam Bypass
				Sub Total (H)	2215	2251	2251	5000	18000	7251	20251	
		Total (Lae Urban:Sum of Sub Total (A) - (H))			93000	94000	104000	12000	38000	106000	142000	
	Ahi Urban	1	HENGALI	---	4312	4540	4771	0	0	4540	4771	Rehabilitation and Function Enhancement
		7	EAST WAGANG	---	1411	1486	1561	2000	4000	3486	5561	Wagan Fishery Villa
		14	LIMKI	---	9403	9901	10405	2500	7000	12401	17405	Ahi Central
		15	KAMKUMUNG	---	2056	2165	2275	2000	4000	4165	6275	Kamkumun Light Industry
		2	BUTIBAM WEST	Zone29	2168	2283	2399	0	0	2283	2399	Rehabilitation and Function Enhancement
		3	BUTIBAM EAST		1768	1862	1956	0	0	1862	1956	
		4	WEST BUKO		635	669	703	0	0	669	703	
		5	EAST BUKO		1274	1341	1410	0	0	1341	1410	
		6	WEST WAGANG		0	0	0	0	0	0	0	
		8	YANGA		5837	6146	6458	2000	4000	8146	10458	Wagan Fishery Villa
		9	GAWANG		5527	5820	6116	0	0	5820	6116	Rehabilitation and Function Enhancement
		10	BUSURUM		1291	1359	1429	0	0	1359	1429	
		11	MALAHANG		545	574	603	0	0	574	603	
		12	BUSU-POASANG		3749	3948	4148	0	0	3948	4148	
		16	POASUM	Zone02	16056	16906	17766	2500	7000	19406	24766	Ahi Central Malahang Industrial Expansion
		Total (Ahi Urban)			56032	59000	62000	11000	26000	70000	88000	
	Wampar	---	---	---	0	0	0	17000	91000	17000	91000	Eivots Garden City North along Yalu-Igam Bypass
		---	---	---	0	0	0	0	37000	0	37000	Eivots Garden City South
		9 10	GAWANG/5 MILE ST JOSEPH	---	7007	8432	11243	4000	5000	12432	16243	Wampar Gate at 5-6 miles
	Total (Water Supply Development in Lae)				156039	161432	177243	44000	197000	205432	374243	
SITUM	Labuta	13	SITUM	---	3958	6597	21769	0	0	6597	21769	
Puahom Garden City	Ahi	13	POAHOM	---	5431	9000	10000	0	20000	9000	30000	
Bubia Industrial Park	Wampar	12	BUBIA	---	3876	4664	6219	0	0	4664	6219	
Yalu Industrial Park	Wampar	14	YALU	---	3047	2695	5005	2000	2000	4695	7005	
Nadzab Airport City	Wampar	17 18	GAPSONGKEG NAROMANGKI	---	0	0	0	4000	22000	4000	22000	
Markham Bridge	Wampar	5	MARKHAM BRIDGE	---	2018	1840	2944	0	1000	1840	3944	
Gabensis	Wampar	3	GABENSIS	---	2125	1937	3100	0	0	1937	3100	
Labu Garden Villa along Markham River	Wampar	8	LABUBUTU	---	1115	1734	2890	0	8000	1734	10890	

Source: JICA Project Team

The water supply area and non-water supply area (non-covered area) in Lae City and neighbouring LLG by Water PNG are as shown below.

Source: Water PNG

Figure 12.4.2 Covered and Non-Covered Area by Water PNG (Lae City)

These current and projected populations of each site are used as the basic data for the water demand of Water Supply Development of this Project.

(2) Land Development Plan – Residential, Commercial & Industrial Area

From the development plan of land use, projected (2025, 2050) land development plans of target sites are as shown below.

Table 12.4.2 Land Development Plan (2025, 2050)

Project Title	Location			Zone (Water PNG)	Area				Remarks
					Total Land Development (ha)		C & I Development Area (ha)		
	LLG	Ward			2025	2050	2025	2050	
		No.	Name						
	Lae Urban	1	ERIKU/BUNDI	Zone21	30	30			Buimo Garden Villa
				Sub Total (A)	30	30	0	0	
		2	TOP TOWN	Zone15	15	90	5	10	Provincial Central at Lae Old Airport
				Sub Total (B)	15	90	5	10	
		3	MAIN MARKET	---	100	600	60	300	Tidal Basin North
				Sub Total (C)	100	600	60	300	
		4	HAIKOST	Zone25			30	100	3-mile Settlement Improve
				Sub Total (D)	0	0	30	100	
		6C	IGAM	---	140	540	10	20	Igam Garden Villa Abong Garden Villa Suburban Central along Yalu-Igam Bypass
				Sub Total (H)	140	540	10	20	
		Total (Lae Urban:Sum of Sub Total (A) - (H))			285	1260	105	430	
	Ahi Urban	7	EAST WAGANG	---	35	90	7.5	10	Wagan Fishery Villa
		14	LIMKI	---	40	140			Ahi Central
		15	KAMKUMUNG	---	60	130	30	40	Kamkumun Light Industry
		8	YANGA	Zone29	35	90	7.5	10	Wagan Fishery Villa
		16	POASUM	Zone29	120	240	80	100	Ahi Central Malahang Industrial Expansion
				Zone02					
		Total (Ahi Urban)			290	690	125	160	
	Wampar	---	---	---	230	1050	0	150	Eivots Garden City North along Yalu-Igam Bypass
		---	---	---	0	700	0	10	Eivots Garden City South
		9	GAWANG/5 MILE	---	60	100	0	0	Wampar Gate at 5-6 miles
	Total (Water Supply Development in Lae)				865	3800	230	750	
SITUM	Labuta	13	SITUM	---	10	10	0	0	
Puahom Garden City	Ahi	13	POAHOM	---	0	800	0	150	
Bubia Industrial Park	Wampar	12	BUBIA	---	0	70	0	50	
Yalu Industrial Park	Wampar	14	YALU	---	90	150	50	100	
Nadzab Airport City	Wampar	17	GAPSONGKEG	---	120	900	9	100	
Markham Bridge	Wampar	5	MARKHAM BRIDGE	---	3	50	1	10	
Gabensis	Wampar	3	GABENSIS	---	2	10	0	0	
Labu Garden Villa along Markham River	Wampar	8	LABUBUTU	---	0	250	0	150	

Source: JICA Project Team

These planned land development areas are utilized for the water demand of water supply development of this Project.

12.4.3 Unit Water Demand and Water Consumption

Water PNG categorizes customers into eight types. The table below shows the customer categories Water PNG is managing in Lae City. In this Project, the plan of water supply development shall follow these categories.

Table 12.4.3 Customer Categories (Lae City - Water PNG)

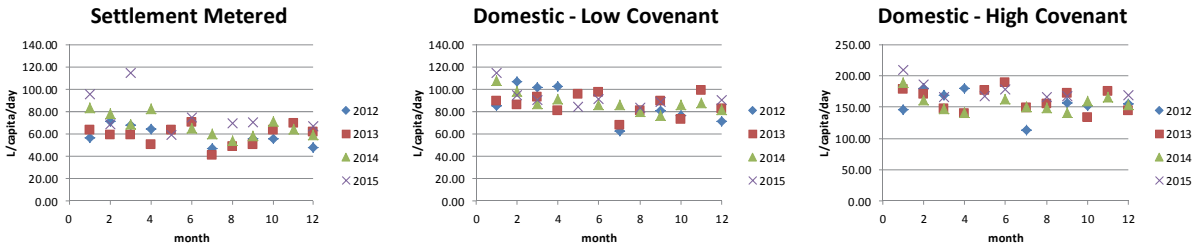
No.	Type	Major Customer
1	Settlement Metered	Household
2	Domestic - Low Covenant	
3	Domestic - High Covenant	
4	Industrial	Industrial factory
5	Commercial	Shop, Hotel, Restaurant, Commercial office etc.
6	Institutional	School, Hospital, Police office, Administrative office, etc.
7	Non Billed Customer	---
8	Others - Common Use	---

Source: Water PNG

(1) Household

a) Lae City – Current Water Supply Area

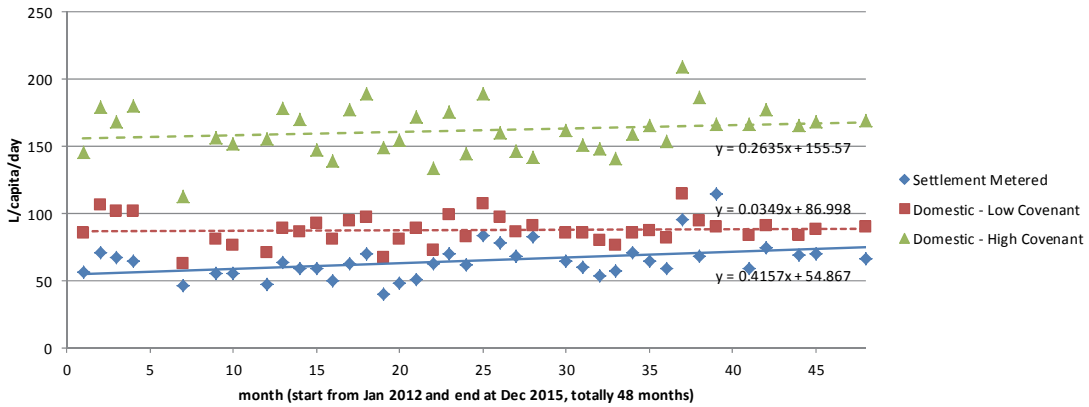
The actual records (2012 – 2015, four years) of unit water demand for households (Settlement Metered, Domestic - Low Covenant, Domestic - High Covenant) are as shown below.



Source: JICA Project Team (Based on the record of Water PNG)

Figure 12.4.3 Actual Unit Water Demand of each Category (Household)

Usage of water per capita varies by category; water usage of "Domestic – High Covenant" has the highest water consumption at about 160 L/capita/day. No obvious seasonal fluctuations of water usage were found. However, roughly speaking, water usage from December to February is high, and from July to August it is low.



Source: JICA Project Team (Based on the record of Water PNG)

Figure 12.4.4 Actual Unit Water Demand of Household (2012 - 2015)

Figure 12.4.4 shows the time-series water usage of each household category. Every category shows an increase of water usage per capita per day (water usage of "Domestic – Low Covenant" increases slightly). Based on this data (actual records), unit water demand of each category in 2025 and 2050 are calculated by the approximation formula as shown in the table below.

Table 12.4.4 Unit Water Demand for Household in Current Water Supply Area

No.	Category	Approximation Formula (Linear Approximation)	Unit Water Demand by Linear Approx. (L/capita/day)			
			2012 (Jan)	2015 (Dec)	2025	2050
1	Settlement Metered	Y = 0.4157X + 54.867	60	61	65	76
2	Domestic - Low Covenant	Y = 0.0349X + 86.998	87	88	88	89
3	Domestic - High Covenant	Y = 0.2635X + 155.57	159	160	162	169

Source: JICA Project Team

For the development and rehabilitation of the current water supply area, these figures are utilized in this Project.

b) New Development Area

In the new development area of "Water Supply Development in Lae" and the other eight target sites, it is assumed that regional and environmental differences vary by each area. However, it is difficult to estimate the unit water demand of each target site without the actual data of current water usage. Therefore, in these areas, this Project follows the categories of household and unit water demand that Water PNG defines. The categories and unit water demands for new development area are as shown below.

Table 12.4.5 Unit Water Demand for Household Defined by Water PNG

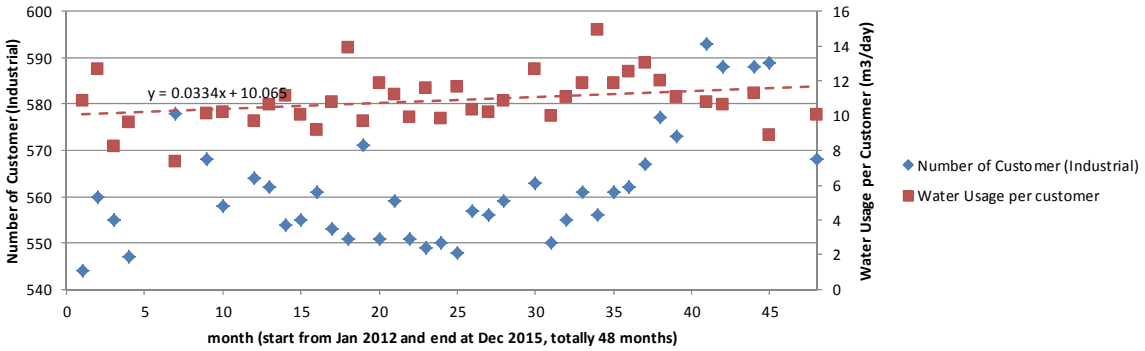
No.	Project Title	Condition Setting	Unit Water Demand (L/capita/day)	
			2025	2050
1	Water Supply Development in Lae			
(1)	Current Water Supply Area by Water PNG	Described above	---	---
(2)	Tidal Basin North	Domestic - High Covenant	162	169
(3)	Wagan Fishery Villa	Domestic - Low Covenant	88	89
(4)	Ahi Central	Domestic - High Covenant	162	169
(5)	Provincial Central at Lae Old Airport	Domestic - High Covenant	162	169
(6)	Kamkumun Light Industry	Domestic - High Covenant	162	169
(7)	Buimo Garden Villa	Domestic - High Covenant	162	169
(8)	Igam Garden Villa	Domestic - Low Covenant	88	89
(9)	Abong Garden Villa	Domestic - Low Covenant	88	89
(10)	Suburban Central along Yalu-Igam Bypass	Domestic - Low Covenant	88	89
(11)	Eivots Garden City North along Yalu-Igam Bypass	Domestic - Low Covenant	88	89
(12)	Eivots Garden City South	Domestic - Low Covenant	88	89
(13)	3-mile Settlement Improve	Domestic - High Covenant	162	169
(14)	Malahang Industrial Expansion	Domestic - High Covenant	162	169
(15)	Wampar Gate at 5-6 miles	Domestic - Low Covenant	88	89
2	SITUM	Domestic - Low Covenant	88	89
3	Puahom Garden City	Domestic - Low Covenant	88	89
4	Bubia Industrial Park	Domestic - High Covenant	162	169
5	Yalu Industrial Park	Domestic - High Covenant	162	169
6	Nadzab Airport City	Domestic - High Covenant	162	169
7	Markham Bridge	Domestic - Low Covenant	88	89
8	Gabensis	Domestic - Low Covenant	88	89
9	Labu Garden Villa along Markham River	Domestic - High Covenant	162	169

Source: JICA Project Team

(2) Industrial, Commercial Customers

a) Lae City – Current Water Supply Area

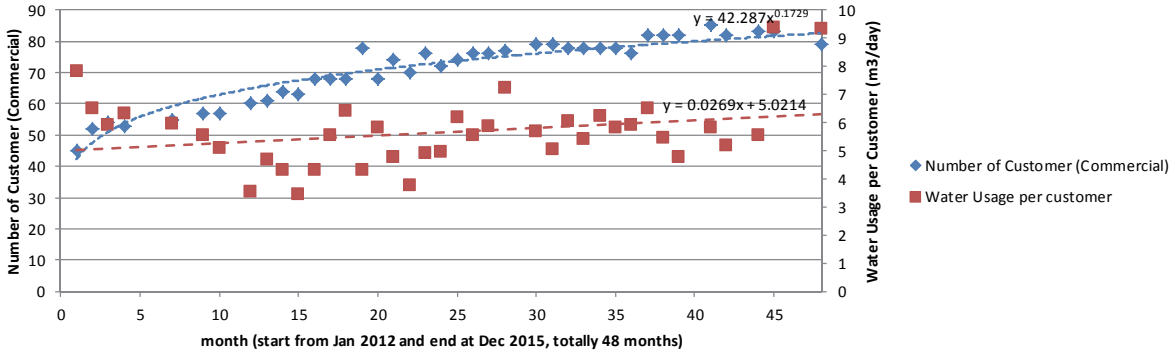
The actual records (2012 – 2015, four years) of unit water demand for Industrial and Commercial Customers are as shown below.



Source: JICA Project Team (Based on the record of Water PNG)

Figure 12.4.5 Actual Unit Water Demand of Industrial Customers (2012 - 2015)

Regarding the industrial customers, the number of customers vary widely each month. On the other hand, water usage per customer has a trend of increasing gradually. Therefore, in this Project, water demands of industrial customers for the current water supply area follow the approximation formula as shown in Figure 12.4.5. The basic year and month for calculation of the future water demand (2025) is set as August, 2015. Current and future industrial areas of the existing water supply area are limited, so the future industrial water demand of 2050 is defined as the same value as 2025.



Source: JICA Project Team (Based on the record of Water PNG)

Figure 12.4.6 Actual Unit Water Demand of Commercial Customers (2012 - 2015)

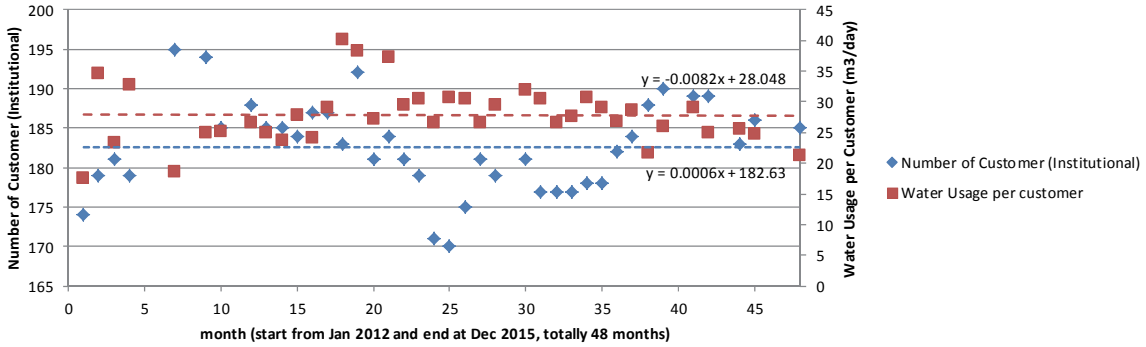
Regarding Commercial customers, the number of customers can be estimated with the approximation formula shown in Figure 12.4.6. In addition, water usage per customer has a trend of increasing gradually. Therefore, in this Project, water demands of commercial customers for the current water supply area follow the approximation formula as shown in Figure 12.4.6. The basic year and month for calculation of the future water demand is set as December 2014. The current and future commercial areas of the existing water supply area are limited, so the future industrial water demand of 2050 is defined as the same value as 2025.

b) New Development Area

In the new development area of this Project, it is difficult to define and set the number and water consumption of future industrial and commercial customers. Therefore, this Project follows the design standard value of Water PNG for the unit water demand of industrial and commercial customers. The defined value in design standard of Water PNG is 10 cubic metres/ ha/day.

(3) Institutional

The actual records (2012 – 2015, four years) of unit water demand for institutional customers are as shown below.



Source: JICA Project Team (Based on the record of Water PNG)

Figure 12.4.7 Actual Unit Water Demand of Institutional Customers (2012 - 2015)

Regarding the institutional customers, the approximation formulas of number of customers and water usage are shown in Figure 12.4.7. Both the numbers of customers and water usage varies each year and month. However, the approximation formulas show that the trend of the number of customers and water usage is almost constant over the past four years. Therefore, in this Project, water demands of institutional customers for the current water supply area follow the current water usage for the water demand of 2025 and 2050.

For the new development area, unit water demand is defined as the unit water demand of current water supply area per hectare. It is calculated as 1.41cubic metres/ha/day.

12.4.4 Necessary Factor for Water Demand

From the value of projected population and development area, water consumption of each category is calculated by multiplying each unit water demand. In this section, necessary factors to calculate the designed water demand of this Project are defined.

(1) Unaccounted for Water

Waste, water leakage, street and pipeline flushing give rise unaccounted-for water losses. In the current water supply area that Water PNG is managing, unaccounted-for water is about 50% (calculated by water production and water consumption data). On the other hand, the design manual of water supply facility of PNG states that the unaccounted-for water should be assumed as 20% of the average daily water consumption. Therefore, this Project follows the ratio of unaccounted-for water as 20% of the average daily water consumption (the sum of per capita, industrial, commercial and institutional demand). However, unaccounted-for water of the current water supply area that Lae City Water PNG is managing is more than 20%. Thus, this Project plans to conduct a full-scale rehabilitation of existing pipelines.

(2) Average Daily Flow (ADF)

According to the design manual of water supply facility of PNG, Average Daily Flow (ADF) is defined as the sum of the average daily water consumption and unaccounted-for water.

(3) Peak Daily Flow (PDF)

The design manual of water supply facility of PNG defines the Peak Daily Flow (PDF) as the ADF multiplied by a factor of between 1.2 and 1.4. This Project sets the PDF as 1.3.

(4) Peak Hourly Flow (PHF)

The design manual of water supply facility of PNG defines the Peak Hourly Flow (PHF) as the PDF multiplied by a factor of between 1.8 and 2.5. In general, higher ratios are applied to small communities. In this Project, the PHF is assigned a factor of 2.5 for the target areas of “SITUM”, “Bubia Industrial Park”, “Yalu Industrial Park”, “Markham Bridge” and “Gabensis”. Other areas are assigned a factor of 1.8.

(5) Design Flows

Each component of the water supply facilities is designed using the flows presented in the next table. These flows are used as design criteria to size each component to provide satisfactory performance.

Table 12.4.6 System Component Design Requirements

Design Component	Design Flow
Water Source	PDF
Headworks	PDF
Trunk Main - Gravity	PDF
Trunk Main - Pumped	120% PDF
* Storage Reservoir - Gravity	50% PDF
* Storage Reservoir - Pumped	PDF
Reticulation - Case 1	PHF
Reticulation - Case 2	ADF+Fire Fighting Flow

* Check Minimum Fire Fighting Reserve

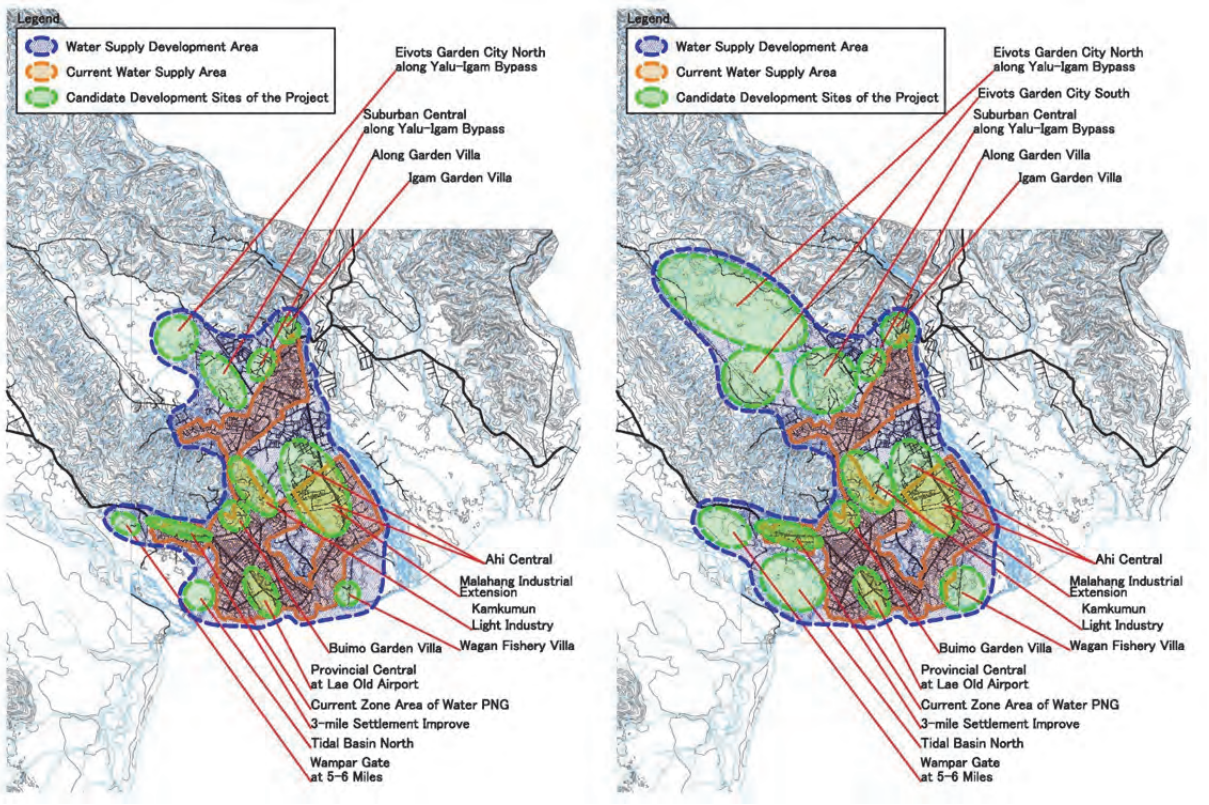
Source: Design Manual for Water Supply and Sewerage (Water PNG)

12.4.5 Master Plan of Water Supply

12.4.5.1 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.



Land Use Plan (2025) Land Use Plan (2050)

Source: JICA Project Team

Figure 12.4.8 Water Supply Area for the Future (2025, 2050)

(2) Water Demand

According to the target area (determined by the land development plan) of the water supply area for the future, water demand for each zone and ward is calculated using the following factors: population, commercial & industrial area and unit water demand.

The specifications of major water supply facilities (water source, trunk main, purification plant,

pump facilities, reservoir, etc.) are planned and designed based on these water demands.

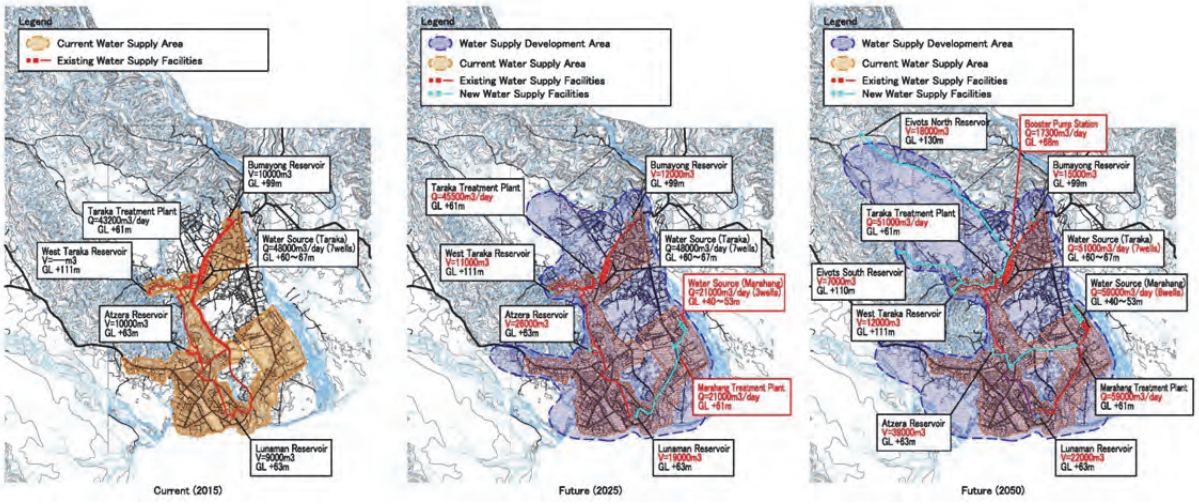
Table 12.4.7 Future Water Demand for Water Supply Development in Lae

Location			Zone (Water PNG)	Water Demand																	
				Habitant						Commercial & Industrial		Institutional		Total		Unaccounted for Water (m3/day)		Average Daily Flow (ADF: m3/day)		Peak Daily Flow (PDF: m3/day)	
LLG	Ward			Settlement Metered		Domestic - Low Covenant		Domestic - High Covenant													
	No.	Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Lae Urban	1	ERIKU/BUNDI	Zone01	42	57	210	246	78	95	160	160	32	32	522	590	104	118	626	708	814	920
			Zone03	0	0	0	0	1515	1830	0	0	636	636	2151	2466	430	493	2581	2959	3355	3847
			Zone04	1	1	56	65	193	234	14	14	271	271	535	585	107	117	642	702	835	913
			Zone05	0	0	7	8	143	172	211	211	52	52	413	443	83	89	496	532	645	692
			Zone06	0	0	5	6	464	561	105	105	89	89	663	761	133	152	796	913	1035	1187
			Zone20	0	0	42	50	513	620	91	91	20	20	666	781	133	156	799	937	1039	1218
			Zone21	24	32	113	133	585	653	77	77	42	42	841	937	168	187	1009	1124	1312	1461
			Zone22	36	49	174	204	70	84	2	2	38	38	320	377	64	75	384	452	499	588
			Sub Total (A)	103	139	607	712	3561	4249	660	660	1180	1180	6111	6940	1222	1387	7333	8327	9534	10826
	2	TOP TOWN	Zone14	0	0	2	3	32	38	121	121	402	402	557	564	111	113	668	677	868	880
			Zone15	0	0	1	1	324	845	137	187	33	139	495	1172	99	234	594	1406	772	1828
			Zone16	0	0	2	3	271	327	316	316	1	1	590	647	118	129	708	776	920	1009
			Zone17	0	0	45	53	340	411	184	184	1	1	570	649	114	130	684	779	889	1013
			Zone18	0	0	30	35	403	487	830	830	225	225	1488	1577	298	315	1786	1892	2322	2460
			Zone19	0	0	79	92	500	605	26	26	69	69	674	792	135	158	809	950	1052	1235
			Sub Total (B)	0	0	159	187	1870	2713	1614	1664	731	837	4374	5401	875	1079	5249	6480	6823	8425
	3	MAIN MARKET	Zone07	0	0	23	27	208	252	38	38	79	79	348	396	70	79	418	475	543	618
			Zone08	0	0	290	340	302	365	526	526	15	15	1133	1246	227	249	1360	1495	1768	1944
			Zone09	0	0	0	0	6	7	1077	1077	0	0	1083	1084	217	217	1300	1301	1690	1691
			Zone10	0	0	1	1	14	17	174	174	8	8	197	200	39	40	236	240	307	312
			Zone11	0	0	4	4	20	24	3679	3679	0	0	3703	3707	741	741	4444	4448	5777	5782
			Zone12	0	0	6	8	202	245	69	69	0	0	277	322	55	64	332	386	432	502
			Zone13	0	0	45	53	69	83	724	724	87	87	925	947	185	189	1110	1136	1443	1477
			---	0	0	0	0	486	2197	600	3000	141	846	1227	6043	245	1209	1472	7252	1914	9428
			Sub Total (C)	0	0	369	433	1307	3190	6887	9287	330	1035	8893	13945	1779	2788	10672	16733	13874	21754
	4	HAIKOST	Zone23	54	73	339	397	143	173	5	5	20	20	561	668	112	134	673	802	875	1043
			Zone24	60	82	303	355	29	35	0	0	6	6	398	478	80	96	478	574	621	746
			Zone25	62	84	241	283	19	22	300	1000	2	2	624	1391	125	278	749	1669	974	2170
			Sub Total (D)	176	239	883	1035	191	230	305	1005	28	28	1583	2537	317	508	1900	3045	2470	3959
	5	UNITECH	Zone28	281	328	788	797	107	111	7	7	574	574	1757	1817	351	363	2108	2180	2740	2834
			Zone32	0	0	88	89	247	258	4	4	21	21	360	372	72	74	432	446	562	580
			Sub Total (E)	281	328	876	886	354	369	11	11	595	595	2117	2189	423	437	2540	2626	3302	3414
	6A	EAST TARAKA	Zone26	4	5	254	257	256	267	4	4	1697	1697	2215	2230	443	446	2658	2676	3455	3479
			Zone30	0	0	15	15	9	9	679	679	257	257	960	960	192	192	1152	1152	1498	1498
			Sub Total (F)	4	5	269	272	265	276	683	683	1954	1954	3175	3190	635	638	3810	3828	4953	4977
	6B	WEST TARAKA	Zone27	21	25	346	350	15	16	3	3	0	0	385	394	77	79	462	473	601	615
			Zone31	5	5	269	272	11	12	1	1	0	0	286	290	57	58	343	348	446	452
			Sub Total (G)	26	30	615	622	26	28	4	4	0	0	671	684	134	137	805	821	1047	1067
	6C	IGAM	---	0	0	638	1802	0	0	100	200	197	761	935	2763	187	553	1122	3316	1459	4311
			Sub Total (H)	0	0	638	1802	0	0	100	200	197	761	935	2763	187	553	1122	3316	1459	4311
	Total (Lae Urban:Sum of Sub Total (A) - (H))			590	741	4416	5949	7574	11055	10264	13514	5015	6390	27859	37649	5572	7527	33431	45176	43462	58733
Ahi Urban	1	HENGALI	---	0	0	0	0	735	806	0	0	0	0	735	806	147	161	882	967	1147	1257
	7	EAST WAGANG	---	0	0	307	495	0	0	75	100	49	127	431	722	86	144	517	866	672	1126
	14	LIMKI	---	0	0	0	0	2009	2941	0	0	56	197	2065	3138	413	628	2478	3766	3221	4896
	15	KAMKUMUNG	---	0	0	0	0	675	1060	300	400	85	183	1060	1643	212	329	1272	1972	1654	2564
	2	BUTIBAM WEST	Zone29	0	0	0	0	370	405	0	0	0	0	370	405	74	81	444	486	577	632
	3	BUTIBAM EAST		0	0	0	0	302	331	0	0	0	0	302	331	60	66	362	397	471	516
	4	WEST BUKO		0	0	0	0	108	119	0	0	0	0	108	119	22	24	130	143	169	186
	5	EAST BUKO		0	0	0	0	217	238	0	0	0	0	217	238	43	48	260	286	338	372
	6	WEST WAGANG		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	YANGA		0	0	717	931	0	0	75	100	49	127	841	1158	168	232	1009	1390	1312	1807
	9	GAWANG		0	0	512	544	0	0	0	0	0	0	512	544	102	109	614	653	798	849
	10	BUSURUM		0	0	0	0	220	242	0	0	0	0	220	242	44	48	264	290	343	377
	11	MALAHANG		0	0	0	0	93	102	0	0	0	0	93	102	19	20	112	122	146	159
	12	BUSU-POASANG		0	0	0	0	640	701	0	0	0	0	640	701	128	140	768	841	998	1093
	16	POASUM		0	0	0	0	3144	4185	800	1000	169	338	4113	5523	823	1105	4936	6628	6417	8616
			Zone02	0	0	0	0	0	0	0	0	0	0								
	Total (Ahi Urban)			0	0	1536	1970	8513	11130	1250	1600	408	972	11707	15672	2341	3135	14048	18807	18263	24450
Wampar	---	---	---	0	0	1496	8099	0	0	0	1500	324	1481	1820	11080	364	2216	2184	13296	2839	17285
	---	---	---	0	0	0	3293	0	0	0	100	0	987	0	4380	0	876	0	5256	0	6833
	9	GAWANG/5 MILE	---	0	0	1094	1446	0	0	0	0	85	141	1179	1587	236	317	1415	1904	1840	2475
Total (Water Supply Development in Lae)				590	741	8542	20757	16087	22185	11514	16714	5832	9971	42565	70368	8513	14071	51078	84439	66404	109776

Source: JICA Project Team

(3) 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 cubic metres storage tanks, ten pressure pumps), four reservoirs (Bumayong, West Taraka, Lunaman, Atzera), trunk mains and distribution mains.



Source: JICA Project Team

Figure 12.4.9 Current (2015) and Future Plan (2025, 2050) Excluding Distribution Main

As a basic concept, this Master Plan redevelops the simple flow of water for easy managing of 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, Water PNG disconnected Atzera reservoir from the distribution main.
To help the situation, this Master Plan considers that all trunk mains are completely separate from distribution mains and are only connected to the treatment plant.
In particular, the trunk main from the Bumayong reservoir to Lunaman reservoir and one of the trunk mains from Taraka treatment plant to Atzera reservoir shall be disconnected and eliminated from the trunk main by 2025. Through the construction of a new treatment plant at the Malahang area (Malahang treatment plant), a new trunk main from the Malahang treatment plant shall be connected to Lunaman reservoir.
By 2050, due to the expansion of the water supply area toward the north of Lae City, the trunk main from the Taraka treatment plant to Lunaman reservoir shall be disconnected, while a new trunk main from the Malahang treatment plant to Atzera reservoir shall be installed.
Regarding the other water supply facilities, water sources, a treatment plant, reservoirs, and distribution mains are planned in accordance with the water demand of 2025 and 2050 calculated by the previous clause.

a) Water Source

Regarding the current water source area (East Taraka), this Master Plan does not consider new development of water source; it only considers rehabilitation of existing boreholes and replacement of submersible pumps. In 2025 and 2050, the water from the current water source shall be used mainly for the north area of Lae City.
New development of water source at the Malahang area shall correspond with increasing water demand in the future. This area is a high potential area for ground water resources. This Master Plan considers the new water source near the new Malahang treatment plant, along Busu River.

b) Trunk Main

Measures of the independent trunk main from the distribution main have already been mentioned earlier. By 2050, in addition to the described measures, trunk mains from West Taraka reservoir to Eivots North reservoir and Eivots South reservoir shall be installed.

c) Treatment Plant

At the Taraka treatment plant (existing treatment plant: 43,200 cubic metres/day), rehabilitation of storage tanks and replacement of pressure pumps shall be considered to be unertaken by 2025. By 2050, this Master Plan considers reinstallation of pressure pumps (51,000 cubic metres/day).
In the Malahang area, a new Malahang treatment plant shall be considered. The capacity in 2025 is 21,000 cubic metres/day and 59,000 cubic metres/day in 2050. There are storage tanks (900 cubic metres in 2025-21,000 cubic metres/24h ; 2500 cubic metres in total in 2050− 59,000 cubic metres/24h), pressure pumps (21,000 cubic metres/day to Lunaman reservoir in 2025; 59,000 cubic metres/day to Lunaman and Atzera reservoir in 2050), chlorine sterilization facilities and a backup generator for blackouts shall be installed. In addition, a pump station and chlorine sterilization station shall be planned.

Source: JICA Project Team

Figure 12.4.10 Candidate Location of Malahang Treatment Plant

d) Pump Station

The current capacity of water supply facilities is insufficient to supply water to the area of "Eivots Garden City North along Yalu-Igam Bypass" and "Eivots Garden City South" in 2050. This Master Plan considers using a booster pump station (pump capacity: 17,285cubic metres/day) to fill the Eivots North reservoir with water in the state land which is located in the south area of Defense Force. In addition, another booster pump station (pump capacity: 6,833cubic metres/day) for Eivots South reservoir shall be considered at the compound of West Taraka Reservoir.

e) Reservoir Tank

In addition to the existing four reservoirs, another two reservoirs shall be considered. Furthermore, due to increasing water demand in 2025 and 2050, compounds of existing reservoirs shall be expanded and additional reservoirs are planned.

Table 12.4.8 Reservoir Plan (Draft)

Reservoir	Capacity (m3)				
	2015	2025		2050	
		New	Total Capacity	New	Total Capacity
Bumayong	10000	2000	12000	3000	15000
West Taraka	---	11000	11000	1000	12000
Lunaman	9000	10000	19000	3000	22000
Atzera	10000	16000	26000	13000	39000
Eivots North	---	0	0	18000	18000
Eivots South	---	0	0	7000	7000

Source: JICA Project Team

f) Reticulation (Distribution Main)

Along with the development of reservoirs, this Master Plan sets the distribution area corresponding to reservoir planning.

Table 12.4.9 Setting of Distribution Area (Draft)

Project Title	Location			Zone (Water PNG)	2025 (m3)						2050 (m3)								Remarks
					Water Source Purification Plant		Reservoir Distribution Area				Water Source Purification Plant		Reservoir Distribution Area						
	LLG	Ward			Taraka	Malahang	Bumanyong	West Taraka	Atzera	Lunaman	Taraka	Malahang	Bumanyong	West Taraka	Atzera	Lunaman	Eivots North	Eivots South	
		No.	Name																
Water Supply Development in Lae	Lae Urban	1	ERIKU/BUNDI	Zone01	814				814			920			920				Rehabilitation and Function Enhancement
				Zone03	3355		1000		2355			3847	1000		2847				
				Zone04	835				835			913			913				
				Zone05	645				645			692			692				
				Zone06	1035				1035			1187			1187				
				Zone20	1039				1039			1218			1218				
				Zone21	1312		1312				1461		1461						Buimo Garden Villa
				Zone22	499		499				588		588						Rehabilitation and Function Enhancement
				Sub Total (A)	9534	0	2811	0	6723	0	2049	8777	3049	0	7777	0	0	0	
		2	TOP TOWN	Zone14		868				868		880				880			Rehabilitation and Function Enhancement
				Zone15		772				772		1828				1828			Provincial Central at Lae Old Airport
				Zone16		920				920		1009				1009			Rehabilitation and Function Enhancement
				Zone17		889				889		1013				1013			
				Zone18		2322				2322		2460				2460			
				Zone19		1052				1052		1235				1235			
				Sub Total (B)	0	6823	0	0	0	6823	0	8425	0	0	0	8425	0	0	
		3	MAIN MARKET	Zone07	543				543			618			618				Rehabilitation and Function Enhancement
				Zone08	1768				1768			1944			1944				
				Zone09	1690				1690			1691			1691				
				Zone10	307				307			312			312				
				Zone11		5777				5777		5782				5782			
				Zone12		432				432		502				502			
				Zone13	1443				1443			1477			1477				
				---		1914			1914			9428			9428				Tidal Basin North
				Sub Total (C)	5751	8123	0	0	7665	6209	0	21754	0	0	15470	6284	0	0	
		4	HAIKOST	Zone23	875				875			1043			1043				Rehabilitation and Function Enhancement
				Zone24	621				621			746			746				
				Zone25	974				974			2170			2170				3-mile Settlement Improve
				Sub Total (D)	2470	0	0	0	2470	0	0	3959	0	0	3959	0	0	0	
		5	UNITECH	Zone28	2740		2740				2834		2834						Rehabilitation and Function Enhancement
				Zone32	562		562				580		580						
				Sub Total (E)	3302	0	3302	0	0	0	3414	0	3414	0	0	0	0	0	
		6A	EAST TARAKA	Zone26	3455			3455			3479			3479					Rehabilitation and Function Enhancement
				Zone30	1498			1498			1498			1498					
				Sub Total (F)	4953	0	0	4953	0	0	4977	0	0	4977	0	0	0	0	
		6B	WEST TARAKA	Zone27	601			601			615			615					Rehabilitation and Function Enhancement
				Zone31	446			446			452			452					
				Sub Total (G)	1047	0	0	1047	0	0	1067	0	0	1067	0	0	0	0	
		6C	IGAM	---	1459			1459			4311			4311					Igam Garden Villa Abong Garden Villa Suburban Central along Yalu-Igam Bypass
				Sub Total (H)	1459	0	0	1459	0	0	4311	0	0	4311	0	0	0	0	
	Total (Lae Urban:Sum of Sub Total (A) - (H))				28516	14946	6113	7459	16858	13032	15818	42915	6463	10355	27206	14709	0	0	
	Ahi Urban	1	HENGALI	---		1147				1147		1257				1257			Rehabilitation and Function Enhancement
		7	EAST WAGANG	---		672				672		1126				1126			Wagan Fishery Villa
		14	LIMKI	---	3221		3221				4896		4896						Ahi Central
		15	KAMKUMUNG	---	1654		1654				2564		2564						Kamkumun Light Industry
		2	BUTIBAM WEST	Zone29		577				577		632				632			Rehabilitation and Function Enhancement
		3	BUTIBAM EAST			471				471		516				516			
		4	WEST BUKO			169				169		186				186			
		5	EAST BUKO			338				338		372				372			
		6	WEST WAGANG			0				0		0				0			
		8	YANGA			1312				1312		1807				1807			Wagan Fishery Villa
		9	GAWANG			798				798		849				849			
		10	BUSURUM			343				343		377				377			
		11	MALAHANG			146				146		159				159			
		12	BUSU-POASANG		998		998				1093		1093						
		16	POASUM	Zone02	6417				6417			8616			8616				Ahi Central Malahang Industrial Expansion
	Total (Ahi Urban)				12290	5973	5873	0	6417	5973	8553	15897	8553	0	8616	7281	0	0	
	Wampar	---	---	---	2839			2839			17285						17285		Eivots Garden City North along Yalu-Igam
		---	---	---	0			0			6833							6833	Eivots Garden City South
		9 10	GAWANG/5 MILE ST JOSEPH	---	1840				1840		2475				2475				Wampar Gate at 5-6 miles
	Total (Water Supply Development in Lae)				45485	20919	11986	10298	25115	19005	50964	58812	15016	11360	38297	21990	17285	6833	

Source: JICA Project Team

Currently, the existing water supply area is divided into 32 zones. However, flow control by water distribution block is not considered in the current distribution system; the water from Bumayong reservoir (highest reservoir) is flowing up to the end of the south area of Lae City The flow control, water pressure control and effective utilization of reservoirs are difficult. This Master Plan divides the water supply area into four water distribution blocks (in 2025) and six water distribution blocks (in 2050) according to the reservoir plan. The water balance for each water distribution block is considered.

12.4.5.2 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 shown below.

Table 12.4.10 Current and Projected Population of Target Sites (2015, 2025, 2050)

Project Title	Location			Population						
				Population in Existing Areas			Poulation in New Development Areas		Future Population in Target Area	
	LLG	Ward		Current	Projection					
		No.	Name	2015	2025	2050	2025	2050	2025	2050
SITUM	Labuta	13	SITUM	3958	6597	21769	0	0	6597	21769
Puahom Garden City	Ahi	13	POAHOM	5431	9000	10000	0	20000	9000	30000
Bubia Industrial Park	Wampar	12	BUBIA	3876	4664	6219	0	0	4664	6219
Yalu Industrial Park	Wampar	14	YALU	3047	2695	5005	2000	2000	4695	7005
Nadzab Airport City	Wampar	17 18	GAPSONGKEG NAROMANGKI	0	0	0	4000	22000	4000	22000
Markham Bridge	Wampar	5	MARKHAM BRIDGE	2018	1840	2944	0	1000	1840	3944
Gabensis	Wampar	3	GABENSIS	2125	1937	3100	0	0	1937	3100
Labu Garden Villa along Markham River	Wampar	8	LABUBUTU	1115	1734	2890	0	8000	1734	10890

Source: JICA Project Team

(2) Land Development Plan – Residential and Commercial & Industrial Area

From the development plan of land use, projected (2025, 2050) land development plan of target sites are as shown below.

Table 12.4.11 Land Development Plan of Target Sites (2025, 2050)

Project Title	Location			Area			
	LLG	Ward		Total Land Development (ha)		C & I Development Area (ha)	
		No.	Name	2025	2050	2025	2050
SITUM	Labuta	13	SITUM	10	10	0	0
Puahom Garden City	Ahi	13	POAHOM	0	800	0	150
Bubia Industrial Park	Wampar	12	BUBIA	0	70	0	50
Yalu Industrial Park	Wampar	14	YALU	90	150	50	100
Nadzab Airport City	Wampar	17 18	GAPSONGKEG NAROMANGKI	120	900	9	100
Markham Bridge	Wampar	5	MARKHAM BRIDGE	3	50	1	10
Gabensis	Wampar	3	GABENSIS	2	10	0	0
Labu Garden Villa along Markham River	Wampar	8	LABUBUTU	0	250	0	150

Source: JICA Project Team

(3) Water Demand

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

Table 12.4.12 Future Water Demand for Water Supply Development in Target Sites

Project Title	Water Demand															
	Habitant				Commercial & Industrial		Institutional		Total		Unaccounted for Water (m3/day)		Average Daily Flow (ADF: m3/day)		Peak Daily Flow (PDF: m3/day)	
	Domestic - Low Covenant		Domestic - High Covenant													
	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
SITUM	0	0	0	0	0	0	14	14	14	14	3	3	17	17	22	22
Puahom Garden City	0	1780	0	0	0	1500	0	1128	0	4408	0	882	0	5290	0	6877
Bubia Industrial Park	0	0	0	0	0	500	0	99	0	599	0	120	0	719	0	935
Yalu Industrial Park	0	0	761	1184	500	1000	127	212	1388	2396	278	479	1666	2875	2166	3738
Nadzab Airport City	0	0	648	3718	90	1000	169	1269	907	5987	181	1197	1088	7184	1414	9339
Markham Bridge	162	351	0	0	10	100	4	71	176	522	35	104	211	626	274	814
Gabensis	170	276	0	0	0	0	3	14	173	290	35	58	208	348	270	452
Labu Garden Villa along Markham River	0	0	281	1840	0	1500	0	353	281	3693	56	739	337	4432	438	5762

Source: JICA Project Team

In this Project, water sources considered are 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 are planned to be constructed on the highest point of each target area.

12.4.5.3 Proposed Projects

Proposed projects are shown below.

Table 12.4.13 Proposed Waer Supply Projects

No.	Project Title	Project Outline	Proposed location	Cost (Mil. PGK)	Schedule
WS-1	Water Supply Development in Lae	Water source Submersible pump Purification plant Booster pump Reservoir tank Pipeline	Lae Urban and Ahi Rural between Markham River and Busu River	461.23	Up to 2050
WS-1-1	Rehabilitation and Function Enhancement	Water source Submersible pump Purification plant Booster pump Reservoir tank Pipeline	Existing Water Supply Area and others	287.48	Up to 2050
WS-1-2	Tidal Basin North	Pipeline	Lae Port North Zone (composite type)	22.15	Up to 2050

No.	Project Title	Project Outline	Proposed location	Cost (Mil. PGK)	Schedule
WS-1-3	Wagan Fishery Villa	Pipeline	Wagan Industrial Zone Development (excluding port construction)	6.64	Up to 2050
WS-1-4	Ahi Central	Pipeline	Ahi Rural Kamkanun	10.33	Up to 2050
WS-1-5	Provincial Central at Lae Old Airport	Pipeline	Lae Old Airport area (composite type)	3.32	Up to 2050
WS-1-6	Kamkumun Light Industry	Pipeline	Kamkumun area	4.80	Up to 2050
WS-1-7	Buimo Garden Villa	Pipeline	Buimo area	1.11	Up to 2025
WS-1-8	Igam Garden Villa	Pipeline	North of Bumayong area	3.69	Up to 2050
WS-1-9	Abong Garden Villa	Pipeline	Bumayong area	1.48	Up to 2025
WS-1-10	Suburban Central along Yalu-Igam Bypass	Booster Pump Station Booster Pump Pipeline	Bumayong area Community & Commercial Centre Improvement (including Bus Terminal)	14.76	Up to 2050
WS-1-11	Eivots Garden City North along Yalu-Igam Bypass	Eivots Garden City North along Yalu-Igam Bypass	Pipeline	68.55	Up to 2050
WS-1-12	Eivots Garden City South	Eivots Garden City South	Pipeline	25.84	After 2025
WS-1-13	3-mile Settlement Improve	Neighboring area of Lae City (Development by community) Pilot Project	Pipeline	3.69	Up to 2050
WS-1-14	Malahang Industrial Expansion	Malahang Industrial Expansion	Pipeline	3.69	Up to 2050
WS-1-15	Wampar Gate at 5-6 miles	West of Lae City	Pipeline	3.70	Up to 2050
WS-2	SITUM	Situm area (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	1.56	Up to 2050
WS-3	Puahom Garden City		Water source Submersible pump Purification plant Reservoir tank Pipeline	84.10	After 2025
WS-4	Bubia Industrial Park		Water source Submersible pump Purification plant Reservoir tank Pipeline	7.55	After 2025

No.	Project Title	Project Outline	Proposed location	Cost (Mil. PGK)	Schedule
WS-5	Yalu Industrial Park	Yalu (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	19.68	Up to 2050
WS-6	Nadzab Airport City	Nearby area of Nadzab Airport (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	93.76	Up to 2050
WS-7	Markham Bridge	Markham Point (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	6.86	Phase I (2018-2020)
WS-8	Gabensis	Gabensis area Community Centre (composite type)	Water source Submersible pump Purification plant Reservoir tank Pipeline	3.71	Phase I (2018-2020)
WS-9	Labu Garden Villa along Markham River	Labu Garden Villa along Markham River	Water source Submersible pump Purification plant Reservoir tank Pipeline	35.20	After 2025

12.5 Sanitation and Sewerage

12.5.1 Development Concept and Planning Frame

(1) Development Concept for Wastewater Management

The following are issues in Lae-Nadzab Area;

- To stop direct discharge of sewage into ocean and to improve ocean water quality,
- To treat sludge of septic tanks and to reduce impact to the environment, and
- To reduce risks on the humans' health through modification of on-site-sanitation from unimproved ones to improved ones.

In order to overcome the issues, development of wastewater management should be undertaken for following concept shown in Table 12.5.1.

Table 12.5.1 Development Concept for Wastewater Management

No.	Concept
1.	To treat the wastewater by either sewerage or on-site-sanitation appropriately according to development stages of urbanization.
2.	To expand / introduce the sewerage for highly populated areas.
3.	To accelerate septic tank installation, one of the improved sanitation systems, for the areas covered by piped water supply.
4.	To treat sludge of septic tanks and sewage at a sewage treatment plant (STP) before discharge.
5.	To improve public education for improvement of on-site-sanitation.

Source: JICA Project Team

In principle, the area to be covered by piped water supply, either sewerage or septic tank system should be extended as shown in Table 12.5.2. On the other hand, the remained areas, which are not planned for the piped water supply, are to be managed by the traditional on-site-sanitation. Nevertheless, improved sanitation should be promoted for the on-site-sanitation.

Table 12.5.2 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 flash toilet.
Non piped water supply area		On-site-sanitation (improved sanitation should be promoted.).

Source: JICA Project Team

The Figure 12.5.1 is a conceptual location map for systems to be taken in this Master Plan. Planning process is described hereunder.

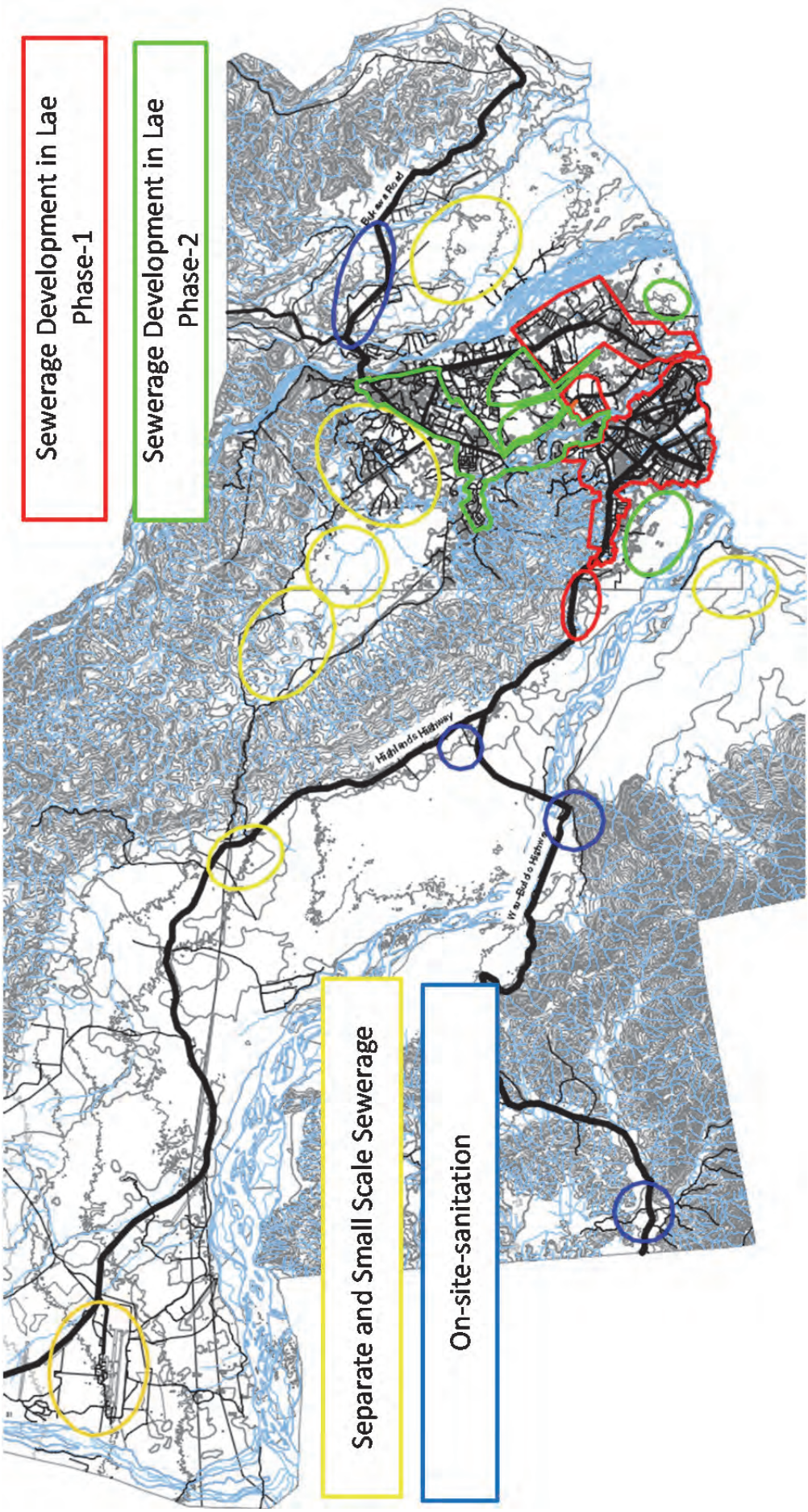


Figure 12.5.1 Cities to Develop Sewerage

Source: JICA Project Team

(2) Implementing Agency

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.

12.5.2 Sanitation and Sewerage Plan

12.5.2.1 Planning Framework

Table 12.5.3 shows the generated wastewater flow in Lae-Nadzab Area, according to the planned flow of water supply.

(1) Planned Wastewater Flow

Planned flow of piped water supply is taken for wastewater flow in this Master Plan.

- Water supply flow = Wastewater flow

Other unforeseen flows, such as infiltration of groundwater and rainwater, are not estimated additionally since the piped water supply flow includes 20% of "unaccounted-for water" that is loss of supplied water like leakage.

(2) Design Wastewater Flow

To design the capacities of sewage treatment plant, peak daily flow of water supply (PDF) is applied for calculation.

- Peak daily flow of water supply (PDF) = Peak daily flow of wastewater (PDWF)

Table 12.5.3 Planned Wastewater Flow in Lae-Nadzab Area

Area		Location			Current Zone (Water PNG)	Population in Target Area		Planned Water Supply (cubic metres/day)				Generated Wastewater Flow (cubic metres/day)			
								Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
		LLG	Ward												
Main	Sub		No.	Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Existing Water Supply Area and Surroundings		Lae Urban	1	ERIKU/BUNDI	Zone01	3,518	4,076	626	708	814	920	626	708	814	920
					Zone03	9,349	10,831	2,581	2,959	3,355	3,847	2,581	2,959	3,355	3,847
					Zone04	1,835	2,127	642	702	835	913	642	702	835	913
					Zone05	960	1,113	496	532	645	692	496	532	645	692
					Zone06	2,923	3,387	796	913	1,035	1,187	796	913	1,035	1,187
					Zone20	3,645	4,224	799	937	1,039	1,218	799	937	1,039	1,218
	Buimo Garden Villa				Zone21	5,263	5,781	1,009	1,124	1,312	1,461	1,009	1,124	1,312	1,461
					Zone22	2,974	3,446	384	452	499	588	384	452	499	588
						30,467	34,985	7,333	8,327	9,534	10,826	7,333	8,327	9,534	10,826
			2	TOP TOWN	Zone14	221	256	668	677	868	880	668	677	868	880
	Provincial Centre at Lae Old Airport				Zone15	2,008	5,010	594	1,406	772	1,828	594	1,406	772	1,828
					Zone16	1,699	1,968	708	776	920	1,009	708	776	920	1,009
					Zone17	2,607	3,021	684	779	889	1,013	684	779	889	1,013
					Zone18	2,828	3,277	1,786	1,892	2,322	2,460	1,786	1,892	2,322	2,460
					Zone19	3,984	4,616	809	950	1,052	1,235	809	950	1,052	1,235
						13,347	18,148	5,249	6,480	6,823	8,425	5,249	6,480	6,823	8,425
			3	MAIN MARKET	Zone07	1,548	1,794	418	475	543	618	418	475	543	618
					Zone08	5,158	5,975	1,360	1,495	1,768	1,944	1,360	1,495	1,768	1,944
					Zone09	37	43	1,300	1,301	1,690	1,691	1,300	1,301	1,690	1,691
					Zone10	100	116	236	240	307	312	236	240	307	312
					Zone11	162	188	4,444	4,448	5,777	5,782	4,444	4,448	5,777	5,782

Area		Location			Current Zone (Water PNG)	Population in Target Area		Planned Water Supply (cubic metres/day)				Generated Wastewater Flow (cubic metres/day)			
								Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
Main	Sub	LLG	Ward No.	Ward Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
					Zone12	1,323	1,534	332	386	432	502	332	386	432	502
					Zone13	936	1,085	1,110	1,136	1,443	1,477	1,110	1,136	1,443	1,477
	Tidal Basin North				---	3,000	13,000	1,472	7,252	1,914	9,428	1,472	7,252	1,914	9,428
						12,264	23,735	10,672	16,733	13,874	21,754	10,672	16,733	13,874	21,754
			4	HAIKOST	Zone23	5,562	6,445	673	802	875	1,043	673	802	875	1,043
					Zone24	4,548	5,270	478	574	621	746	478	574	621	746
	3-mile Settlement				Zone25	3,812	4,417	749	1,669	974	2,170	749	1,669	974	2,170
						13,922	16,132	1,900	3,045	2,470	3,959	1,900	3,045	2,470	3,959
			5	UNITECH	Zone28	13,933	13,933	2,108	2,180	2,740	2,834	2,108	2,180	2,740	2,834
					Zone32	2,522	2,522	432	446	562	580	432	446	562	580
						16,455	16,455	2,540	2,626	3,302	3,414	2,540	2,626	3,302	3,414
			6A	EAST TARAKA	Zone26	4,525	4,525	2,658	2,676	3,455	3,479	2,658	2,676	3,455	3,479
					Zone30	225	225	1,152	1,152	1,498	1,498	1,152	1,152	1,498	1,498
						4,750	4,750	3,810	3,828	4,953	4,977	3,810	3,828	4,953	4,977
			6B	WEST TARAKA	Zone27	4,343	4,343	462	473	601	615	462	473	601	615
					Zone31	3,201	3,201	343	348	446	452	343	348	446	452
						7,544	7,544	805	821	1,047	1,067	805	821	1,047	1,067
						98,749	121,749	32,309	41,860	42,003	54,422	32,309	41,860	42,003	54,422
		Ahi Urban	1	HENGALI	---	4,540	4,771	882	967	1,147	1,257	882	967	1,147	1,257
	Wagan Fishery Park		7	EAST WAGANG	---	3,486	5,561	517	866	672	1,126	517	866	672	1,126
	Kamkumun Settlement		14	LIMKI	---	12,401	17,405	2,478	3,766	3,221	4,896	2,478	3,766	3,221	4,896
	Kamkumun Industrial Area		15	KAMKUMUNG	---	4,165	6,275	1,272	1,972	1,654	2,564	1,272	1,972	1,654	2,564

Area		Location			Current Zone (Water PNG)	Population in Target Area		Planned Water Supply (cubic metres/day)				Generated Wastewater Flow (cubic metres/day)			
		LLG	Ward					Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
Main	Sub		No.	Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
			2	BUTIBAM WEST	Zone29	2,283	2,399	444	486	577	632	444	486	577	632
			3	BUTIBAM EAST		1,862	1,956	362	397	471	516	362	397	471	516
			4	WEST BUKO		669	703	130	143	169	186	130	143	169	186
			5	EAST BUKO		1,341	1,410	260	286	338	372	260	286	338	372
			6	WEST WAGANG		0	0	0	0	0	0	0	0	0	0
	Wagan Fishery Park		8	YANGA		8,146	10,458	1,009	1,390	1,312	1,807	1,009	1,390	1,312	1,807
			9	GAWANG		5,820	6,116	614	653	798	849	614	653	798	849
			10	BUSURUM		1,359	1,429	264	290	343	377	264	290	343	377
			11	MALAHANG		574	603	112	122	146	159	112	122	146	159
			12	BUSU -POASANG		3,948	4,148	768	841	998	1,093	768	841	998	1,093
	Malahang Industrial Park		16	POASUM	Zone02	19,406	24,766	4,936	6,628	6,417	8,616	4,936	6,628	6,417	8,616
						70,000	88,000	14,048	18,807	18,263	24,450	14,048	18,807	18,263	24,450
	Wampar Gate at 5-6 miles	Wampar	---	---		12,432	16,243	1,415	1,904	1,840	2,475	1,415	1,904	1,840	2,475
						181,181	225,992	47,772	62,571	62,106	81,347	47,772	62,571	62,106	81,347
Remote Areas / Separate Management	Suburban Central along Yalu-Igam Bypass, incl. Igam Garden Villa, Abong Garden Villa		---	---	---	7,251	20,251	1,122	3,316	1,459	4,311	1,122	3,316	1,459	4,311
	Eivots Garden Centre North along Yalu-Igam Bypass		---	---	---	17,000	91,000	2,184	13,296	2,839	17,285	2,184	13,296	2,839	17,285

Area		Location			Current Zone (Water PNG)	Population in Target Area		Planned Water Supply (cubic metres/day)				Generated Wastewater Flow (cubic metres/day)			
								Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
Main	Sub	LLG	Ward No.	Ward Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
	Eivots Garden Centre South		---	---	---	0	37,000	0	5,256	0	6,833	0	5,256	0	6,833
	SITUM		---	---	---	6,597	21,769	17	17	22	22	17	17	22	22
	Puahom Garden City		---	---	---	9,000	30,000	0	5,290	0	6,877	0	5,290	0	6,877
	Bubia Industrial Park		---	---	---	4,664	6,219	0	719	0	935	0	719	0	935
	Yalu Industrial Park		---	---	---	4,695	7,005	1,666	2,875	2,166	3,738	1,666	2,875	2,166	3,738
	Nadzab Airport City		---	---	---	4,000	22,000	1,088	7,184	1,414	9,339	1,088	7,184	1,414	9,339
	Markham Bridge		---	---	---	1,840	3,944	211	626	274	814	211	626	274	814
	Gabensis		---	---	---	1,937	3,100	208	348	270	452	208	348	270	452
	Labu Tourism Village along Markham River		---	---	---	1,734	10,890	337	4,432	438	5,762	337	4,432	438	5,762
Ground Total						239,899	479,170	54,605	105,930	70,988	137,715	54,605	105,930	70,988	137,715

Source: JICA Project Team

12.5.2.2 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. The area presently covered by water supply has following conditions:

- Trunk sewers are laid along main streets,
- Branch sewers are not completely installed.
- It is difficult for most of water supply customers to connect sanitation facilities to the sewers due to incomplete branch sewers.
- City development / expansion is planned in periphery zones of Lae Urban and Ahi Rural, until 2025 and/or 2050.

Accordingly, phasing development is recommended as shown in Table 12.5.4. In Phase-1, the areas presently covered by trunk sewers should be prioritized for development. Unitec and East Taraka, however, are less prioritized since they have small-scale sewerage with stabilization ponds. Those areas, therefore, should be excluded from Phase-1.

In Phase-2, the system should be expanded to whole area presently covered by water supply as well as its surrounding areas in which the water supply will be developed. Moreover, the small-scale sewerages for Unitec and East Taraka should be combined with the main sewerage to be developed in this Phase-2.

Table 12.5.4 Phasing for Sewerage Development in Lae

Phase	Target Year	Covering Area
Phase-1	2025	- Presently covered by water supply and surroundings, and - Presently covered by trunk sewers and surroundings, but - Excluding Unitec and East Taraka
Phase-2	Later than 2025 and by 2050	- Unitec and East Taraka and surroundings, and - Presently covered by water supply and surroundings, but - Presently not-covered by trunk sewers.

Source: JICA Project Team

(2) UNITEC and East Taraka Areas

The small-scale sewerage systems for UNITEC and East Taraka Areas are presently operative. Nevertheless, it is recommendable to be rehabilitated and turned into conventional sewerage due to following reasons;

- Capacity is limited to receive the sewage generated in surrounding areas.
- Stabilization ponds are not suitable for the urbanization to be expected in long term until 2050.

Accordingly, the systems are recommended to be combined with the main sewerage system for Lae City after Phase-1.

(3) Remote Areas / New Development Areas to be Taken in Sewerage System for Lae

Remote areas shown in Table 12.5.5 are taken in the sewerage system in Lae City.

Table 12.5.5 Remote Areas to be Taken In Sewerage Development in Lae

Area	Target Phase	Conditions / Reasons
Provincial Centre at Lae Old Airport	Phase-1	- Centre of sewerage covering area, and urban development is expected in early stage.
3-mile settlement	Phase-1	- Closed to the sewerage covering area, and urban development is expected in early stage.
Wampar Gate at 5-6 miles	Phase-1	- Closed to the sewerage covering area, and urban development is expected in early stage.
Wagan Fishery Park (Present water supply area)	Phase-1	- Closed to the sewerage covering area, and urban development is expected in early stage.
Malahang Industrial Park	Phase-1	- Closed to the sewerage covering area, and highly populated in present.
Tidal Basin North	Phase-2	- Closed to the sewerage covering area, but highly populated after 2025.
Wagan Fishery Park (Newly developed area)	Phase-2	- Closed to the sewerage covering area, but highly populated after 2025.
Kamkumun Industrial Area	Phase-2	- Closed to the sewerage covering area, but highly populated after 2025, and far from the planned sewage treatment plant
Ahi Rural (Kamkumun settlement)	Phase-2	- Closed to the sewerage covering area, but highly populated after 2025, and far from the planned sewage treatment plant

Source: JICA Project Team

(4) Design Wastewater Flow for Sewerage Development in Lae

According to the aforementioned phasing, the design wastewater flows are calculated as shown in Table 12.5.6. In 2050, the wastewater flow is forecasted to reach 82,000 cubic metres/day. By 2025, a half of the flow; 41,000 cubic metres/day should be managed by sewerage for Lae Urban and Ahi Rural.

Table 12.5.6 Design Wastewater Flow for Sewerage Development in Lae

Area		Location			Current Zone (Water PNG)	Service Population in Target Area		Planned Water Supply (cubic metres/day)				Design Wastewater Flow (cubic metres/day)			
								Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
		LLG	Ward												
Main	Sub		No.	Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Sewerage Development in Lae		Lae Urban	1	ERIKU/BUNDI	Zone01	3,518	4,076	626	708	814	920	626	708	814	920
					Zone03		10,831	2,581	2,959	3,355	3,847	2,581	2,959		3,847
					Zone04	1,835	2,127	642	702	835	913	642	702	835	913
					Zone05	960	1,113	496	532	645	692	496	532	645	692
					Zone06	2,923	3,387	796	913	1,035	1,187	796	913	1,035	1,187
					Zone20	3,645	4,224	799	937	1,039	1,218	799	937	1,039	1,218
	Buimo Garden Villa				Zone21	5,263	5,781	1,009	1,124	1,312	1,461	1,009	1,124	1,312	1,461
					Zone22	2,974	3,446	384	452	499	588	384	452	499	588
						21,118	34,985	7,333	8,327	9,534	10,826	7,333	8,327	6,179	10,826
			2	TOP TOWN	Zone14	221	256	668	677	868	880	668	677	868	880
	Provincial Centre at Lae Old Airport				Zone15	2,008	5,010	594	1,406	772	1,828	594	1,406	772	1,828
					Zone16	1,699	1,968	708	776	920	1,009	708	776	920	1,009
					Zone17	2,607	3,021	684	779	889	1,013	684	779	889	1,013
					Zone18	2,828	3,277	1,786	1,892	2,322	2,460	1,786	1,892	2,322	2,460
					Zone19	3,984	4,616	809	950	1,052	1,235	809	950	1,052	1,235
						13,347	18,148	5,249	6,480	6,823	8,425	5,249	6,480	6,823	8,425
			3	MAIN MARKET	Zone07	1,548	1,794	418	475	543	618	418	475	543	618
					Zone08	5,158	5,975	1,360	1,495	1,768	1,944	1,360	1,495	1,768	1,944
					Zone09	37	43	1,300	1,301	1,690	1,691	1,300	1,301	1,690	1,691
					Zone10	100	116	236	240	307	312	236	240	307	312
					Zone11	162	188	4,444	4,448	5,777	5,782	4,444	4,448	5,777	5,782

Area		Location			Current Zone (Water PNG)	Service Population in Target Area		Planned Water Supply (cubic metres/day)				Design Wastewater Flow (cubic metres/day)			
		LLG	Ward					Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
Main	Sub		No.	Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
					Zone12	1,323	1,534	332	386	432	502	332	386	432	502
					Zone13	936	1,085	1,110	1,136	1,443	1,477	1,110	1,136	1,443	1,477
	Tidal Basin North				---		13,000	1,472	7,252	1,914	9,428	1,472	7,252		9,428
						9,264	23,735	10,672	16,733	13,874	21,754	10,672	16,733	11,960	21,754
			4	HAIKOST	Zone23	5,562	6,445	673	802	875	1,043	673	802	875	1,043
					Zone24	4,548	5,270	478	574	621	746	478	574	621	746
	3-mile Settlement				Zone25	3,812	4,417	749	1,669	974	2,170	749	1,669	974	2,170
						13,922	16,132	1,900	3,045	2,470	3,959	1,900	3,045	2,470	3,959
			5	UNITECH	Zone28		13,933	2,108	2,180	2,740	2,834	2,108	2,180		2,834
					Zone32		2,522	432	446	562	580	432	446		580
						0	16,455	2,540	2,626	3,302	3,414	2,540	2,626	0	3,414
			6A	EAST TARAKA	Zone26		4,525	2,658	2,676	3,455	3,479	2,658	2,676		3,479
					Zone30		225	1,152	1,152	1,498	1,498	1,152	1,152		1,498
						0	4,750	3,810	3,828	4,953	4,977	3,810	3,828	0	4,977
			6B	WEST TARAKA	Zone27		4,343	462	473	601	615	462	473		615
					Zone31		3,201	343	348	446	452	343	348		452
						0	7,544	805	821	1,047	1,067	805	821	0	1,067
						57,651	121,749	32,309	41,860	42,003	54,422	32,309	41,860	27,432	54,422
		Ahi Urban	1	HENGALI	---		4,771	882	967	1,147	1,257	882	967		1,257
	Wagan Fishery Park		7	EAST WAGANG	---		5,561	517	866	672	1,126	517	866		1,126
	Kamkumun Settlement		14	LIMKI	---		17,405	2,478	3,766	3,221	4,896	2,478	3,766		4,896
	Kamkumun Industrial Area		15	KAMKUMUNG	---		6,275	1,272	1,972	1,654	2,564	1,272	1,972		2,564

Area		Location			Current Zone (Water PNG)	Service Population in Target Area		Planned Water Supply (cubic metres/day)				Design Wastewater Flow (cubic metres/day)			
								Average Daily Flow (ADF)		Peak Daily Flow (PDF)		Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)	
Main	Sub	LLG	Ward No.	Ward Name		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
			2	BUTIBAM WEST	Zone29	2,283	2,399	444	486	577	632	444	486	577	632
			3	BUTIBAM EAST		1,862	1,956	362	397	471	516	362	397	471	516
			4	WEST BUKO		669	703	130	143	169	186	130	143	169	186
			5	EAST BUKO		1,341	1,410	260	286	338	372	260	286	338	372
			6	WEST WAGANG		0	0	0	0	0	0	0	0	0	0
	Wagan Fishery Park		8	YANGA		8,146	10,458	1,009	1,390	1,312	1,807	1,009	1,390	1,312	1,807
			9	GAWANG		5,820	6,116	614	653	798	849	614	653	798	849
			10	BUSURUM		1,359	1,429	264	290	343	377	264	290	343	377
			11	MALAHANG		574	603	112	122	146	159	112	122	146	159
			12	BUSU-POASANG		3,948	4,148	768	841	998	1,093	768	841	998	1,093
	Malahang Industrial Park		16	POASUM	Zone29 / Zone02	19,406	24,766	4,936	6,628	6,417	8,616	4,936	6,628	6,417	8,616
						45,408	88,000	14,048	18,807	18,263	24,450	14,048	18,807	11,569	24,450
	Wampar Gate at 5-6 miles	Wampar	---	---			16,243	1,415	1,904	1,840	2,475	1,415	1,904		2,475
	Total					103,059	225,992	47,772	62,571	62,106	81,347	47,772	62,571	39,001	81,347

Source: JICA Project Team

(5) Sewage Treatment

1) Treatment Process

Three options are proposed for sewage treatment process. Those options are common worldwide and characteristics are shown in Table 12.5.7.

Table 12.5.7 Options for Sewage Treatment Process

Aspect	Option-1 Activated Sludge	Option-2 Oxidation Ditch	Option-3 Aerated Lagoon
System	Conventional system for middle / large scale cities. In general, Primary sedimentation + Aeration + Secondary sedimentation.	Common for small / middle scale city. In general, Aeration + Sedimentation.	Aerated large pond. Common in developing countries or regions having enough land space.
Necessary land space	Retention time for aeration: 6 - 8 hours Smaller land space	Retention time for aeration: 24 - 48 hours Medium land space	Retention time for aeration: 30 days or more Larger land space
Construction cost excluding land acquisition	Higher	Higher	Lower
Operation	Difficult	Easier	Very easy

Source: JICA Project Team

Among the options, Option-2; Oxidation Ditch is recommended because of the following conditions:

- Water PNG has no experience of sewage treatment through activated sludge. Therefore, easier system for operation is recommended.
- It is difficult to secure the land for aerated lagoon. Necessary land for oxidation ditch, however, is able to be secured in Tidal Basin North.

2) Treatment Capacity

As aforementioned in the clause of wastewater flows, the following capacity should be provided:

Phase-1:	41,000 cubic metres/day
Phase-2:	41,000 cubic metres/day
Total:	82,000 cubic metres/day

3) Location

Proposed site is in Tidal Basin North as shown in Figure 12.5.2 and Figure 12.5.3. It is closed to the planned site for solid waste landfill.

Source: JICA Project Team on Google Earth

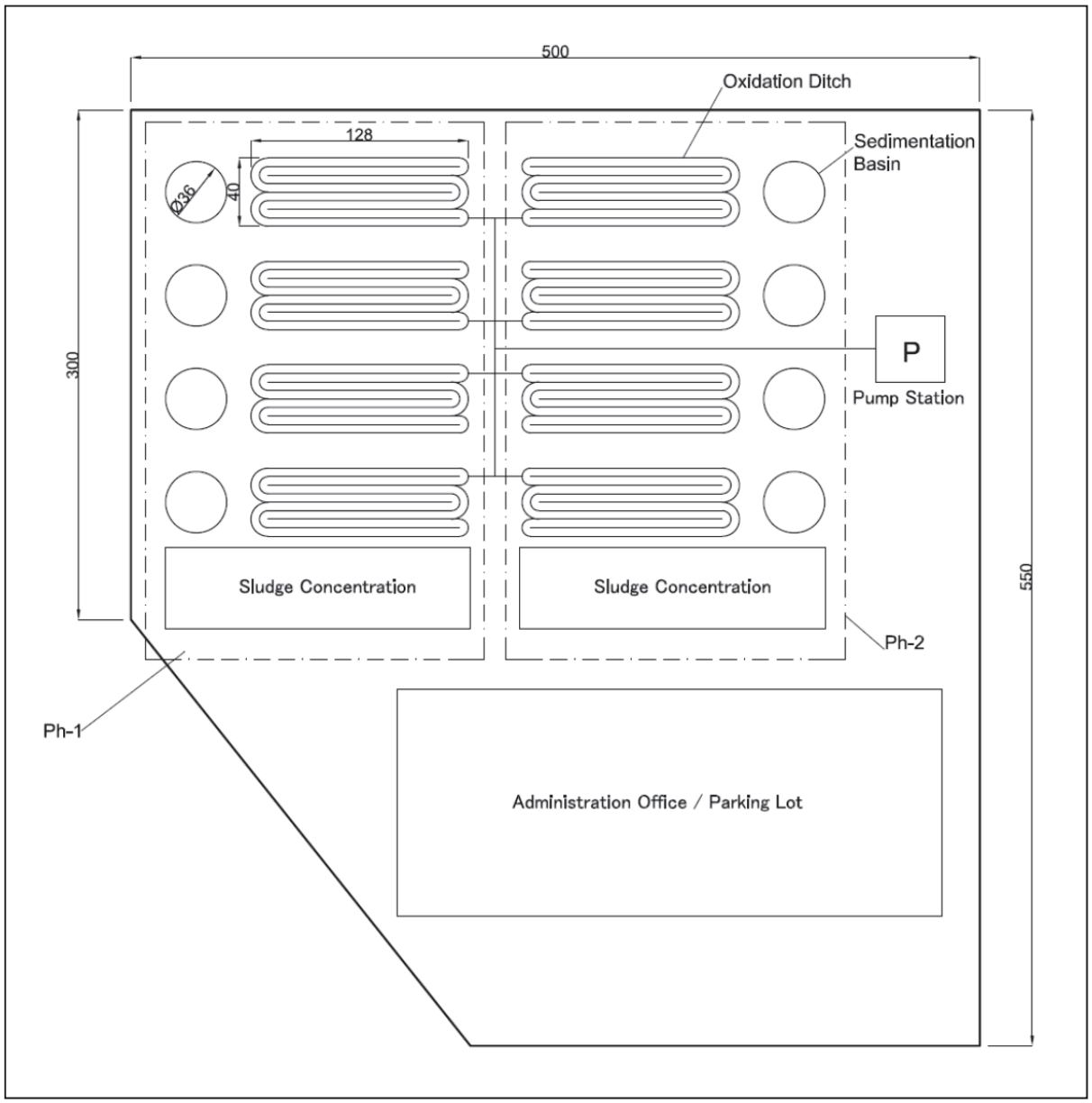
Figure 12.5.2 Location of Planned Site for Sewage Treatment Plant in Lae (1)

Source: JICA Project Team

Figure 12.5.3 Location of Planned Site for Sewage Treatment Plant in Lae (2)

4) Layout of Facilities

In Phase-1, a half of capacity; 41,000 cubic metres/day should be constructed. Thereafter, another half should be constructed along with demand increase. Conceptual layout is shown in Figure 12.5.4. As for the generated sludge, it is recommended to dry it in the Phase-2 extension yard after concentration for the Phase-1 stage. In the Phase-2 stage, mechanical dryer will be necessary due to the limited land space. In both Phase-1 and 2, the dried sludge should be disposed in the solid waste landfill site.



Source: JICA Project Team

Figure 12.5.4 Conceptual Layout of Sewage Treatment Plant for Lae

5) Relay Pump Station and Existing Outfall Station

In present, the sewage of Lae Urban and Ahi Rural is collected by sewers into an outfall station which is located at the southern edge of Lae City. To utilize the existing sewer system, a relay pump station should be provided at the location of outfall station. There is enough land space.

Capacity of the relay pump station should be designed according to peak hourly flow. The peak hourly flow is assumed at 150% of the peak daily flow in this Master Plan.

Phase-1:	61,500 cubic metres/day (42.7cubic metres/min)
Phase-2:	61,500 cubic metres/day (42.7cubic metres/min)
Total:	123,000 cubic metres/day (85.4cubic metres/min)

6) Sewer Networks

Although some trunk sewers are laid in Lae Urban, branch sewers are not completed. Therefore,

the network construction should be completed as well as necessary rehabilitation and up-sizing of diameters. For the other areas, the sewers should be extended according to city urbanization. According to the phasing plan of sewerage development, sewer networks shown in Table 12.5.8 should be constructed.

Phase-1: 2,633 hectares
Phase-2: 2,447 hectares
Total: 5,080 hectares

Table 12.5.8 Necessary Sewer Network Area for Sewerage Development in Lae

Area		Location			Current Zone (Water PNG)	Planned Sewer Area (ha)		
		LLG	Ward			PH1	PH2	Extend
Main	Sub		No.	Name		2025	2050	in PH2
Sewerage Development in Lae		Lae Urban	1	ERIKU/BUNDI	Zone01	70	70	
					Zone03		284	284
					Zone04	32	32	
					Zone05	38	38	
					Zone06	109	109	
					Zone20	63	63	
	Buimo Garden Villa				Zone21	85	85	
					Zone22	53	53	
						451	735	284
			2	TOP TOWN	Zone14	31	31	
	Provincial Centre at Lae Old Airport				Zone15	80	155	75
					Zone16	85	85	
					Zone17	62	62	
					Zone18	140	140	
					Zone19	71	71	
						468	543	75
			3	MAIN MARKET	Zone07	50	50	
					Zone08	107	107	
					Zone09	49	49	
					Zone10	43	43	
					Zone11	50	50	
					Zone12	29	29	
					Zone13	66	66	
	Tidal Basin North				---		600	600
						394	994	600
			4	HAIKOST	Zone23	72	72	
					Zone24	70	70	
	3-mile Settlement				Zone25	41	41	
						184	184	0

Area		Location			Current Zone (Water PNG)	Planned Sewer Area (ha)		
			Ward			PH1	PH2	Extend
Main	Sub	LLG	No.	Name		2025	2050	in PH2
			5	UNITECH	Zone28		314	314
					Zone32		223	223
						0	536	536
			6A	EAST TARAKA	Zone26		56	56
					Zone30		71	71
						0	127	127
			6B	WEST TARAKA	Zone27		51	51
					Zone31		43	43
						0	95	95
						1,496	3,213	1,717
		Ahi Urban	1	HENGALI	---	1,014	1,704	690
	Wagan Fishery Park		7	EAST WAGANG	---			
	Kamkumun Settlement		14	LIMKI	---			
	Kamkumun Industrial Area		15	KAMKUMUNG	---			
			2	BUTIBAM WEST	Zone29			
			3	BUTIBAM EAST				
			4	WEST BUKO				
			5	EAST BUKO				
			6	WEST WAGANG				
	Wagan Fishery Park		8	YANGA				
			9	GAWANG				
			10	BUSURUM				
			11	MALAHANG				
			12	BUSU-POASANG				
	Malahang Industrial Park		16	POASUM				
					Zone02	62	62	
						1,077	1,767	690
	Wampar Gate at 5-6 miles	Wampar	---	---		60	100	40
	Total					2,633	5,080	2,447

Source: JICA Project Team

12.5.2.3 Sewerage Development for Remote Areas

For remote areas, wastewater management should be separately undertaken per area according to the wastewater flow. In larger cases of wastewater flow, small-scale sewerage system is recommendable. On the other hand, on-site-sanitation having septic tank is recommended for smaller cases of wastewater flow.

(1) Planning Conditions and Systems to be Applied

Small-scale sewerage is recommended for the remote cities having 1,000 cubic metres/day of wastewater flow or more. Systems to be applied, on-site-sanitation or small-scale sewerage, are recommended in Table 12.5.9 as well as capacity of sewage system.

For the cities to apply on-site-sanitation, wastewater flows should be monitored along with the city urbanization. According to increase of wastewater flow, small-scale sewerage should be introduced.

Sewerage is not required in 2025 for the following three cities because of low wastewater flow although it may be necessary in 2050.

- Eivots Garden City South
- Puahom Garden City
- Labu Garden Villa along Markham River

For the three cities, on-site-sanitation is recommended until 2025. Later than 2025, requirement of sewerage should be examined according to the city urbanization.

Table 12.5.9 Planning Conditions and Recommended Systems for Remote Cities

Area		Planned Population in Target Area		Generated Wastewater Flow (cubic metres/day)				by On-site-sanitation (cubic metres/day)		by Sewerage					
				Average Daily Flow (ADWF)		Peak Daily Flow (PDWF)				Flow (cubic metres/day)		STP Capacity (cubic metres/day)		Sewer Area (ha)	
								PH1	PH2	PH1	PH2	PH1	PH2	PH1	PH2
		2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050	2025	2050
Remote Areas / Separate Management	Suburban Central along Yalu-Igam Bypass, incl. Igam Garden Villa, Abong Garden Villa	7,251	20,251	1,122	3,316	1,459	4,311			1,459	4,311	1,500	4,500	140	540
	Eivots Garden Centre North along Yalu-Igam Bypass	17,000	91,000	2,184	13,296	2,839	17,285			2,839	17,285	3,000	18,000	230	1050
	Eivots Garden Centre South	0	37,000	0	5,256	0	6,833				6,833		7,000		700
	SITUM	6,597	21,769	17	17	22	22	22	22						
	Puahom Garden City	9,000	30,000	0	5,290	0	6,877				6,877		7,000		800
	Bubia Industrial Park	4,664	6,219	0	719	0	935		935						
	Yalu Industrial Park	4,695	7,005	1,666	2,875	2,166	3,738			1,900	3,738	1,900	3,800	90	150
	Nadzab Airport City	4,000	22,000	1,088	7,184	1,414	9,339			1,414	9,339	1,900	9,500	120	900
	Markham Bridge	1,840	3,944	211	626	274	814	274	814						
	Gabensis	1,937	3,100	208	348	270	452	270	452						
	Labu Tourism Village along Markham River	1,734	10,890	337	4,432	438	5,762	438			5,762		6,000		250
Ground Total		58,718	253,178	6,833	43,359	8,882	56,368	1,270	2,223	7,612	54,145	8,300	55,800	580	4,390

Source: JICA Project Team

(2) On-site-sanitation

In remote cities, the piped water supply is planned by 2025 or 2050. According to progress of house connections of water supply, flush toilet users will be increased. In such case, pit latrines that are traditionally utilized are not appropriate. Septic tanks, therefore, should be promoted.

To promote the septic tank system, Water PNG should undertake the following:

- To instruct water supply customers about installing septic tanks.
- To present model structure and/or standard design of septic tanks in public.

(3) Small Scale Sewerage

1) Treatment Process

In small-scale cities, it is often difficult to deploy always an operation / maintenance team. Easier system in operation is, therefore, preferable for the remote city. Three options shown in Table 12.5.10 are proposed for sewage treatment process for small-scale sewerage.

Table 12.5.10 Options for Sewage Treatment Process

Aspect	Option-1 Oxidation Ditch	Option-2 Contact Aeration	Option-3 Membrane Bio-Reactor
System	Common for small / middle scale city. In general, Aeration + Sedimentation.	Treatment by activated sludge grown on contact media. In general, Primary sedimentation + Aeration + Secondary sedimentation. No requirement of sludge returning.	Membrane filtration. No requirement of sedimentation process in general.
Necessary land space	Retention time for aeration: 24 - 48 hours Medium land space	Retention time for aeration: 10 hours Smaller land space	Very small land space because of filtration system.
Construction cost excluding land acquisition	Same level.		
Operation	Easier	Easier Necessary for contact media maintenance. Necessary for countermeasures for smell in primary sedimentation.	Usual operation: easy Filter maintenance: difficult

Source: JICA Project Team

Among the options, Option-1; Oxidation Ditch is recommended because of the following conditions:

- Better effluent quality is expected for membrane bio-reactor. It is becoming one of the major systems for small-scale sewerage. It is, however, disadvantageous in membrane maintenance, especially procurement of spare membranes.
- Contact aeration is one of the advantageous processes for operation and maintenance. It is good for the remote cities.
- If necessary land space is available, oxidation ditch is preferable because the operational skills to be matured in Lae City will be effective. In this Master Plan, oxidation ditch is recommended. If no enough land space is available in a detail urbanization plan, the contact aeration should be selected.

2) Site of Sewage Treatment Plant

Since no detailed urbanization plan is available, sites for sewage treatment plants are not designated. The sites should be selected along with the detail urbanization plans, taking the following conditions into consideration:

- Enough distance from residential areas.
- Nearer place to effluent discharge points such as river and sea.

3) Sewerage Introduction in Stages (Labu Tourism Village)

Although the small-scale sewerage is proposed in Labu Tourism Village along Markham River for 2050, its population is planned at 2,000 persons or less in 2025. In Phase-1 stage, the small-scale sewerage will be unnecessary. Septic tank system is, therefore, proposed for Phase-1. After 2025, Water PNG should monitor the demand and develop the sewerage according to city urbanization.

12.5.2.4 On-site-sanitation for Uncovered Areas of Water Supply

In uncovered areas of water supply, no septic tank system is basically necessary as well as sewerage. Exceptionally, dwellers having private water pump and flash toilet system should provide a septic tank in a self-help basis. Nevertheless, promotion of improved sanitation is indispensable. It is one of roles of MPA. Improved sanitation is exampled below:

- Flush/pour flush to pit latrine
- Ventilated improved pit latrine (VIP)
- Pit latrine with slab
- Composting toilet
-

12.5.2.5 Industrial Wastewater Management

Industrial wastewater may contain chemicals, metals and some toxic materials. Such wastewater is not able to be treated by conventional sewage treatment plants. Water PNG should instruct factories, which are desirous of sewer connections, about self-help treatments before effluent discharge into the sewers. Guideline should be prepared and opened in public by Water PNG.

12.5.3 Sanitation and Sewerage Projects

(1) Sanitation and Sewerage Projects

Major proposed projects for wastewater management sector are summarized below.

Table 12.5.11 Proposed Wastewater Management Projects

No.	Project Title	Project Outline	Proposed location	Cost (Mil. PGK)	Schedule
SW-1	Sewerage Development in Lae Phase-1	To develop sewer networks in Lae Urban and Ahi Rural between Markham River and Busu River, Southern area than Taraka.	Lae Urban and Ahi Rural between Markham River and Busu River, Southern area than Taraka	-	-
SW-1-1	Rehabilitation and Function Enhancement	Rehabilitation of sewer network (2,452 hectares) Construction of pump station to sewage treatment plant	Existing Sewer Area in Lae Urban and Ahi Rural	218.40	Up to 2025
SW-1-2	Lae Sewage Treatment Plant (STP) PH-1	Sewage treatment plant construction for 41,000 cubic metres/day	Tidal Basin North	133.37	Up to 2025
SW-1-3	Provincial Centre Development at Lae old Airport PH-1	Sewer network construction (80 hectares)	Lae Old Airport	5.62	Up to 2025
SW-1-4	3-mile Settlement Improve	Sewer network construction (41 hectares)	3-mile Settlement	2.88	Up to 2025

No.	Project Title	Project Outline	Proposed location	Cost (Mil. PGK)	Schedule
SW-1-5	Wampar Gate Development PH-1	Sewer network construction (60 hectares)	Wampar Gate	4.21	Up to 2025
SW-2	Sewerage Development in Lae Phase-2	To develop / extend sewer networks in Lae Urban and Ahi Rural along with city development	Lae Urban and Ahi Rural	-	-
SW-2-1	Rehabilitation and Extension	Rehabilitation / Extension of Sewer network (758ha)	Lae Urban and Ahi Rural	53.23	Up to 2050
SW-2-2	Lae Sewage Treatment Plant (STP) PH-2	41,000 cubic metres/day extension for sewage treatment plant Extension of Pump station to STP	Tidal Basin North	179.59	Up to 2050
SW-2-3	Sewer Extension along Independence Road	Sewer network construction (284ha)	Along Independence Road	19.94	Up to 2050
SW-2-4	Provincial Centre Development at Lae old Airport PH-2	Sewer network construction (75ha)	Lae Old Airport	5.27	Up to 2050
SW-2-5	Tidal Basin North Development	Sewer network construction (600 hectares)	Tidal Basin North	42.13	Up to 2050
SW-2-6	Wagan Fishery Park Development	Sewer network construction (180 hectares)	Wagan Fishery Park	12.64	Up to 2050
SW-2-7	Ahi Rural (KamKanun Area) Settlement Expansion for 30,000	Sewer network construction (140 hectares)	Kam Kanun Area	9.83	Up to 2050
SW-2-8	Kamkumun Industrial Area Development (composite type)	Sewer network construction (130 hectares)	Kamkumun Industrial Area	9.13	Up to 2050
SW-2-9	Wampar Gate Development PH-2	Sewer network construction (40 hectares)	Wampar Gate	2.81	Up to 2050
SW-2-10	Malahang Industrial Park Development	Sewer network construction (240 hectares)	Malahang Industrial Park	16.85	Up to 2050
SW-3	Suburban Central Development along Yalu-Igam Bypass	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (1,500 cubic metres/day) Sewer network (140 hectares) PH-2: Sewage Treatment Plant (3,000 cubic metres/day extension) Sewer network (400 hectares)	Suburban Central along Yalu-Igam Bypass	67.27	PH-1: Up to 2025 PH-2: Up to 2050
SW-4	Eivots Garden Centre North sewerage Development along Yalu-Igam Bypass	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (3,000 cubic metres/day) Sewer network (230 hectares) PH-2: Sewage Treatment Plant (15,000 cubic metres/day extension) Sewer network (820 hectares)	Eivots Garden Centre North along Yalu-Igam Bypass	158.19	PH-1: Up to 2025 PH-2: Up to 2050
SW-5	Eivots G.C. South sewerage Development	To develop the following facilities along with city development: Sewage Treatment Plant (7,000 cubic metres/day) Sewer network (700 hectares)	Eivots G.C. South	71.92	Up to 2050

No.	Project Title	Project Outline	Proposed location	Cost (Mil. PGK)	Schedule
SW-6	Puahom Garden City sewerage Development	To develop the following facilities along with city development: Sewage Treatment Plant (7,000 cubic metres/day) Sewer network (800 hectares)	Puahom Garden City	78.94	Up to 2050
SW-7	Yalu Industrial Park sewerage Development	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (1,900 cubic metres/day) Sewer network (90 hectares) PH-2: Sewage Treatment Plant (1,900 cubic metres/day extension) Sewer network (60 hectares)	Yalu Industrial Park	35.39	PH-1: Up to 2025 PH-2: Up to 2050
SW-8	Airport City sewerage Development	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (1,900 cubic metres/day) Sewer network (120 hectares) PH-2: Sewage Treatment Plant (7,600 cubic metres/day extension) Sewer network (780 hectares)	Airport City	108.71	PH-1: Up to 2025 PH-2: Up to 2050
SW-9	Labu Tourism Village Development	To develop the following facilities along with city development: Sewage Treatment Plant (6,000 cubic metres/day) Sewer network (250 hectares)	i	37.07	Up to 2050

Source: JICA Project Team

(2) Construction Costs

Necessary construction cost is shown in Table 12.5.12 and Table 12.5.13.

Table 12.5.12 Construction Cost of Sewerage Development in Lae

Item	Phase-1		Phase-2		Total
	Specification	1000 PGK	Specification	1000 PGK	1000 PGK
a) Sewage Treatment Plant	41,000 cubic metres/day	112,261	41,000 cubic metres/day	112,261	224,522
b) Relay Pump Station	42.7cubic metres/min	38,909	42.7cubic metres/min	38,909	77,818
c) Sewer Networks	2,633 hectares	155,625	2,447 hectares	144,632	300,257
Sub-total A d)=a) + b) + c)		306,795		295,802	602,597
In Direct Cost e)	10% of d)	30,680	10% of d)	29,580	60,260
Sub-total B f)= d) + e)		337,475		325,382	662,857
Design and Supervision Fee g)	8% of f)	26,998	8% of f)	26,031	53,029
Ground Total h)= f) + g)		364,472		351,413	715,885

Source: JICA Project Team

Table 12.5.13 Construction Cost of Small Scale Sewerage for Remote Cities

Item	Phase-1		Phase-2		Total
	Specification	1000 PGK	Specification	1000 PGK	1000 PGK
Suburban Central along Yalu-Igam Bypass, incl. Igam Garden Villa, Abong Garden Villa					
a) Sewage Treatment Plant	1,500 cubic metres/day	4,107	4,500 cubic metres/day	12,321	16,428
b) Sewer Networks	140 hectares	8,275	540 hectares	31,917	40,192
Sub-total A c)=a) + b)		12,382		44,238	56,620
In Direct Cost d)	10% of c)	1,238	10% of d)	4,424	5,662
Sub-total B e)= c) + d)		13,620		48,662	62,282
Design and Supervision Fee f)	8% of e)	1,090	8% of f)	3,893	4,983
Total g)= e) + f)		14,710		52,555	67,265
Eivots Garden Centre North along Yalu-Igam Bypass					
a) Sewage Treatment Plant	3,000 cubic metres/day	8,214	18,000 cubic metres/day	49,285	57,499
b) Sewer Networks	230 hectares	13,594	1,050 hectares	62,061	75,655
Sub-total A c)=a) + b)		21,808		111,346	133,154
In Direct Cost d)	10% of c)	2,181	10% of d)	11,135	13,315
Sub-total B e)= c) + d)		23,989		122,481	146,469
Design and Supervision Fee f)	8% of e)	1,919	8% of f)	9,798	11,718
Total g)= e) + f)		25,908		132,279	158,187
Eivots Garden Centre South					
a) Sewage Treatment Plant		0	7,000 cubic metres/day	19,166	19,166
b) Sewer Networks		0	700 hectares	41,374	41,374
Sub-total A c)=a) + b)		0		60,540	60,540
In Direct Cost d)	10% of c)	0	10% of d)	6,054	6,054
Sub-total B e)= c) + d)		0		66,594	66,594
Design and Supervision Fee f)	8% of e)	0	8% of f)	5,328	5,328
Total g)= e) + f)		0		71,922	71,922
Puahom Garden City					
a) Sewage Treatment Plant		0	7,000 cubic metres/day	19,166	19,166
b) Sewer Networks		0	800 hectares	47,285	47,285
Sub-total A c)=a) + b)		0		66,451	66,451
In Direct Cost d)	10% of c)	0	10% of d)	6,645	6,645
Sub-total B e)= c) + d)		0		73,096	73,096
Design and Supervision Fee f)	8% of e)	0	8% of f)	5,848	5,848
Total g)= e) + f)		0		78,944	78,944
Yalu Industrial Park					
a) Sewage Treatment Plant	1900 cubic metres/day	5,202	3,800 cubic metres/day	10,405	15,607
b) Sewer Networks	90 hectares	5,320	150 hectares	8,866	14,186
Sub-total A c)=a) + b)		10,522		19,271	29,793
In Direct Cost d)	10% of c)	1,052	10% of d)	1,927	2,979
Sub-total B e)= c) + d)		11,574		21,198	32,772

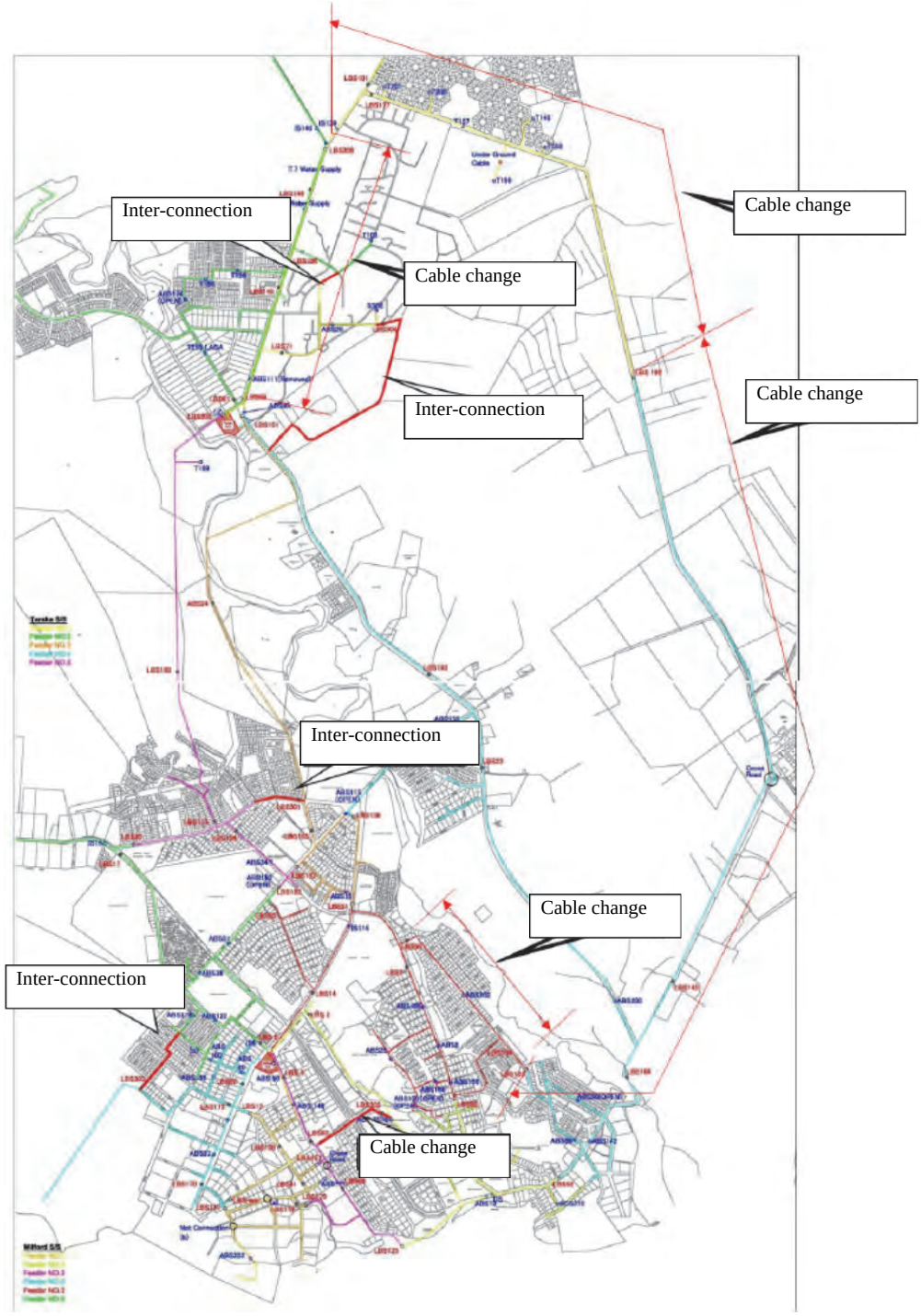
Item	Phase-1		Phase-2		Total
Design and Supervision Fee f)	8% of e)	926	8% of f)	1,696	2,622
Total g)= e) + f)		12,500		22,894	35,394
Nadzab Airport City					
a) Sewage Treatment Plant	1,900 cubic metres/day	5,202	9,500 cubic metres/day	26,012	31,214
b) Sewer Networks	120 hectares	7,093	900 hectares	53,196	60,289
Sub-total A c)=a) + b)		12,295		79,208	91,503
In Direct Cost d)	10% of c)	1,230	10% of d)	7,921	9,150
Sub-total B e)= c) + d)		13,525		87,129	100,653
Design and Supervision Fee f)	8% of e)	1,082	8% of f)	6,970	8,052
Total g)= e) + f)		14,606		94,099	108,706
Labu Tourism Village along Markham River					
a) Sewage Treatment Plant		0	6,000 cubic metres/day	16,428	16,428
b) Sewer Networks		0	250 hectares	14,777	14,777
Sub-total A c)=a) + b)		0		31,205	31,205
In Direct Cost d)	10% of c)	0	10% of d)	3,121	3,121
Sub-total B e)= c) + d)		0		34,326	34,326
Design and Supervision Fee f)	8% of e)	0	8% of f)	2,746	2,746
Total g)= e) + f)		0		37,072	37,072
Ground Total		67,724		489,764	557,488

Source: JICA Project Team

12.6 Power Supply

Currently "Lae Are Distribution Network Improvement Plan" funded by JICA is in progress. The description of Power Supply Plan in this Report is an excerpt from "Lae Area Distribution Network Improvement Plan".

12.6.1 Short-Term Distribution Network Improvement Plan



Source: Lae Area Distribution Network Improvement Plan (Draft) funded by JICA

Figure 12.6.1 Short-Term Distribution Network Improvement

Importance was put on the reduction of blackout duration rather than on the reduction of number of blackout in the short-term distribution network improvement plan for the reliability improvement of electricity supply.

Therefore, reinforcement of the facilities that becomes constraint for distribution facility operation. Also 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 covered by each substation will be divided into blocks and electricity supply routes from substation to each block are prepared as a Long Term Distribution Network Improvement Plan up to 2030.

(1) Electricity Demand Forecast

As a result, total electricity demand in Lae area in 2030 is estimated at three times larger than present one. Total load of Taraka and Milford substations is estimated at 115MW.

Table 12.6.1 Electricity Demand Estimate in Lae area

	Year	2015	2020	2025	2030
Demand load	Milford	21	32	46	61
((MW)	Taraka	19	29	42	54
(A)	Nadzab	0.3	0.3	3	10
	Total	40.3	61.3	91	125

Source: Lae Area Distribution Network Improvement Plan (Draft) funded by JICA

(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. Moreover, Dobel and Ramu1 substations are connected by a 132kV on circuit transmission line. However, the transmission line between Dobel and Ramu1 substations is constructed as a single circuit of the steel tower for dual-circuits and when it becomes impossible to meet the demand of Highland area via the existing 66kV one circuit transmission line in future, it will be upgraded to 132kV.

Note: Blue line: 275kV transmission lime
Red line: 132kV transmission line
Black line: Existing 66kV transmission line
Source: Lae Area Distribution Network Improvement Plan (Draft) funded by JICA

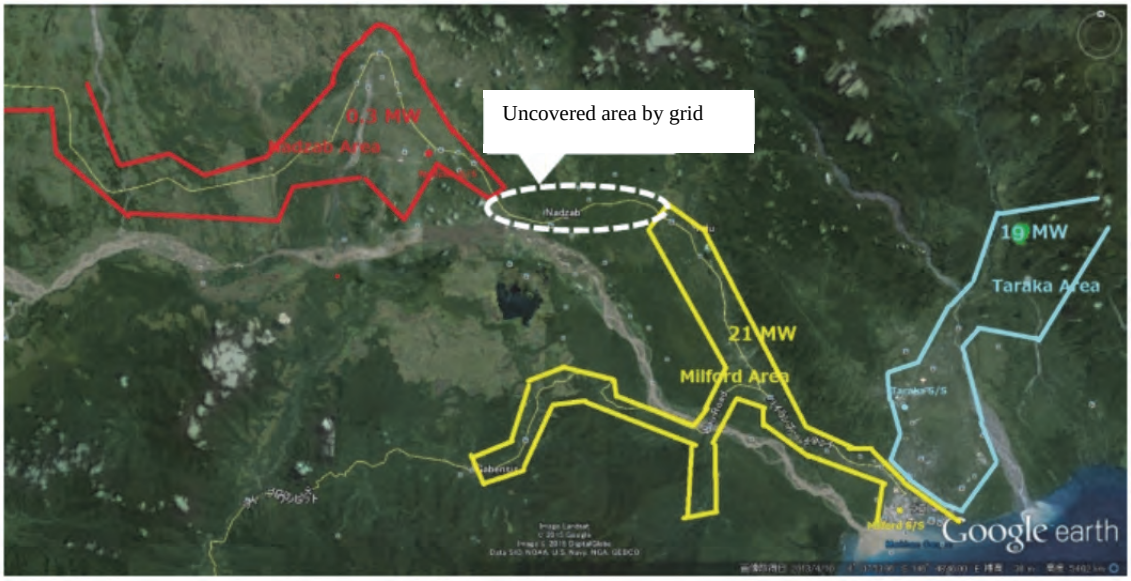
Figure 12.6.2 System Construction by 2030

(3) Electricity Supply Block Plan

Nadzab substation will be abolished due to internationalization Nadazab Airport and Erap Substation will be newly established.
In the Plan, Labu area, Eviot area along proposed Yalu-Igam Highway are not covered by those substations. In the occasion of land use project implementation of Labu, Yalu-Igam area, revision of the electricity supply block plan will be necessary.

Source: Lae Area Distribution Network Improvement Plan (Draft) funded by JICA

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



Source: Lae Area Distribution Network Improvement Plan (Draft) funded by JICA

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

Table 12.6.2 Electricity Demand of Taraka and Milford Substations by Block (2030)

Block	Electricity Supply Area 2030 (km^2)	Electricity Load 2015 (MW)	Electricity Load Density 2015 (kW/km^2)	Increase In Existing Electricity Load (kW/km^2)	New Electricity Load 2030 (MW)	Sub-total (MW)	Adjustment (MW)	Electricity Load 2030 (MW)	Electricity Load Density 2030 (kW/km^2)	Remarks
	(1)	(2)	(3)	(4)	(5)	(6)= (4)+(5)	(7)	(8)= (6)+(7)	(8)/(1)	
T1	18.22	5.5	0.61	9.5	6.9	16.3	0	16	0.90	Industry, school, residence

Block	Electricity Supply Area 2030 (km^2)	Electricity Load 2015 (MW)	Electricity Load Density 2015 (kW/km^2)	Increase In Existing Electricity Load (kW/km^2)	New Electricity Load 2030 (MW)	Sub-total (MW)	Adjustment (MW)	Electricity Load 2030 (MW)	Electricity Load Density 2030 (kW/km^2)	Remarks
	(1)	(2)	(3)	(4)	(5)	(6)= (4)+(5)	(7)	(8)= (6)+(7)	(8)/(1)	
T2	10.29	1.0	6.90	1.1	8.0	9.1	3	12	1.11	Industry, residence
T3	11.09	4.0	1.0	8.1	5.3	13.3	3	16	1.47	Industry, school, residence
T4	4.92	2.0	0.54	2.0	0.9	2.8	7	10	2.00	Industry, residence
Taraka Subtotal	45.15	12.5	0.74	20.5	21.0	41.6	13	54	1.20	
M1	5.35	12.4	2.93	13.4	2.3	15.6	0	16	2.99	Commerce, residence
M2	2.71	9.2	4.97	15.5	1.7	17.2	3	20	7.47	Commerce, heavy industry
M3	3.97	4	1.43	5.9	2.4	8.3	5	14	3.36	Heavy industry, residence
M4	8.00	2.6	0.52	2.2	6.1	8.4	3	11	1.37	Industry, residence
Milford Subtotal	20.04	28.2	2.03	37.1	42.0	49.6	11	61	3.02	
Total	65.19	40.7	1.33	57.6	63.0	91.2	24	115	1.77	

Source: Lae Area Distribution Network Improvement Plan (Draft) funded by JICA

12.7 Communication

12.7.1 Communication Infrastructure Development Strategies

The long-term communication development strategy of Papua New Guinea is outlined in the Vision 2050. The target of the Vision 2050 is to increase the communication access to 100% of the population. To achieve this, the Government plan is to develop an effective information and communication strategy for Vision 2050. A more elaborate targets are provided in the "Papua New Guinea Medium Development Strategic Plan (PNGDSP) 2011-2030", and "Medium Term Development Plan (MTDP) 2010-2015", as explained below.

The government plans to achieve the set goals by undertaking policy reforms to encourage private sectors investment. It also plans to reduce the cost of international communications by easing access to international gateways. Overall, the strategies proposed by the PNGDSP 2010-2030 to achieve the stated goals are as follows:

- Carrying out phase 2 reforms of the Government's ICT policy, and introducing a competitive market in the provision of internet and fixed landline services
- Utilizing PPP to provide services where they are otherwise commercially unviable in order to achieve the PNGDSP targets by 2030
- Maintaining mutually beneficial relationships with international ICT organizations and ensuring compliance with international conventions, standards practices and trends
- Expanding government services to rural communities using mobile phone and internet technologies.

12.7.2 Communication Infrastructure Development Plans

The PNGDSP 2010-2030 target is to increase the number of mobile subscribers per 1000 population to 800. Similarly, the plan aims 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 from 55% to 100%, according to the plan. As Table 12.7.1 shows, the 2030 target is set to be achieved through gradual 5-year plans.

Table 12.7.1 Targets of Development Strategy Plans

DSP sector goal	Indicators	Baseline: 2010	2015 target	2020 target	2025 target	2030 DSP target
A modern and affordable information and communication technology that reaches all parts of the country	Access to a telephone (mobile subscribers per 1000 people)	650	700	750	780	**800**
	Percentage of population with access to internet	2.3%	20%	50%	60%	**70%**
	Percentage of population with media coverage	55% access to radio 25% access to TV, mostly in urban area	Radio: 65% TV : 54%	Radio: 75% TV : 65%	Radio: 85% TV : 85%	**100% access to radio and TV**
Lead government department	Department of Communication and Information (DCI)					

Source: Department of National Planning and Monitoring

Table 12.7.2 shows specific actions that should be carried out in the five-year plans to achieve the 2030 targets. The National Information and Communications Technology Authority (NICTA), a government agency which regulates the information and communication technology was established in late 2010. The investment in the first five years (2011- 2015) is estimated at 69.2 PGK.

Table 12.7.2 Communication Infrastructure Development Plans

2030 deliverables	2011-2015	2016-2020	2021-2025
Mobile subscriber: 800 per 1000 Internet access: 70%	• Establish National Information and Communications Technology Authority (NICTA) to oversee competitive rollout of phone and internet services. • Ensure regulatory framework is conducive for private sector investment.	• If access to phone and internet services do not meet 2030 target, undertake feasibility of options for extending access including satellite and tele centres. • Continue rehabilitating provincial radio stations.	• Implement findings of feasibility study to achieve PNGDSP targets • Sustainable level of management
Radio and TV coverage: 100%	• Rehabilitation of provincial radio stations on the basis of satisfactory performances.		

Source: NICTA

The main challenges in realizing the 2030 target includes accessing land. Resource availability and securing political support for the information and communication development strategies are also mentioned as additional concerns that should be addressed.

Although there are apparent developments in the communication sector (for example, Digicel coverage figures shown below), it is important to assess the developments made by all firms involved in the sector to get more accurate picture. This is also important to evaluate the progress of the implementation of the plan.

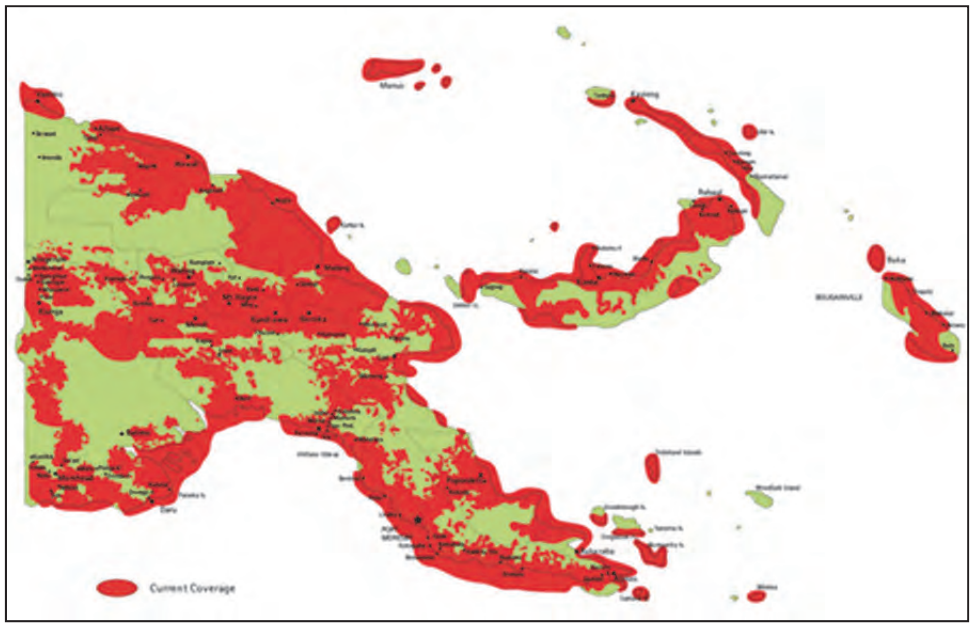


Figure 12.7.1 Digicel Current Coverage (Source: Digicel PNG)

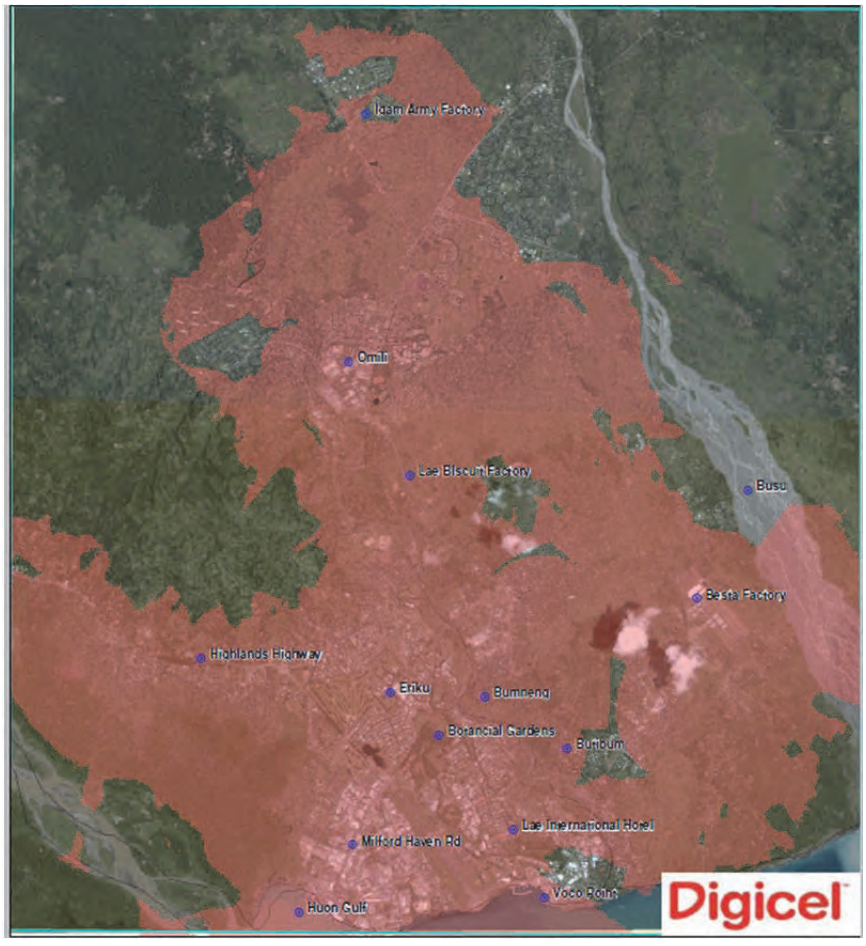


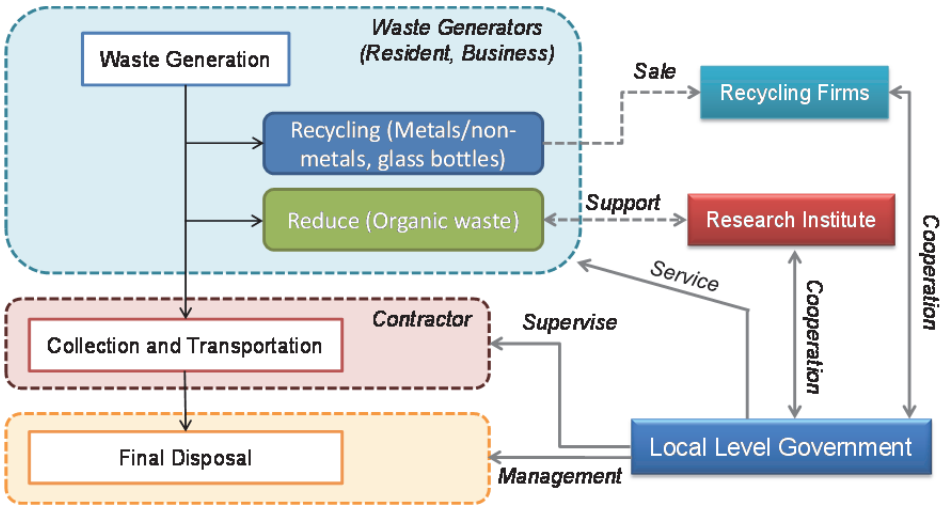
Figure 12.7.2 Digicel Mobile Broadband Coverage in Lae (Source: Digicel PNG)

12.8 Solid Waste Management

12.8.1 Development Direction

12.8.1.1 Development Policy

Establishment of a proper solid waste management system is the key factor to ensure safe and clean life for people. In the waste management process, a lot of stakeholders such as local governments, business operators, citizens, and recovery and recycling firms are involved and their mutual cooperation is essential to accomplish the management process successfully as presented in . Besides the solid waste management policy should be developed considering the current management conditions of local level governments and area characteristics in terms of commercial and industry. Since this Master Plan focuses on the industry development in this area, the waste management system harmonizing with each projected industry should be developed.



Source: JICA Project Team

Figure 12.8.1 Waste Management Process and Stakeholders

The sector vison of solid waste management is “Creating a Recycling Society and Sanitary Environment, and Realizing Eco-friendly Industrial Development through 3Rs Activities”. The 3Rs activities are important factor 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 made great success in terms of natural and social environment. The sector vision can be achieved by conducting basic policies as follows.

Sector Vision

Creating a recycling society and sanitary environment, and realizing eco-friendly industrial development through 3Rs activities

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

(1) [Basic Policy 1] Formulating Broad-based By-law for Solid Waste Management in the Project Area

As of year 2016, only LULLG has its own by-law for solid waste management as described in Section 6.8.1. For steady implementation of the sector vision, the establishment of broad-based legislative system for solid waste management is indispensable.

(2) [Basic Policy 2] Promoting 3Rs Activities

Sanitary environment can be effectively realized through segregation of recyclables and organic wastes at generation sources. At present there are recovery and recycling or reuse routes for metal/non-metal and glass bottles operated by private firms. Firstly the existing recovery and recycling facilities should be utilized as much as possible and the recycling activity is broadly conducted in the Project Area. Secondly, the reduction of organic waste should be tackled from pilot project and implementation on domestic waste.

In addition to general wastes, industrial wastes to be generated due to industry development projects should be utilized through 3Rs activities as much as possible in future.

(3) [Basic Policy 3] Rehabilitation of Existing Dumpsite and Construction of Sanitary Landfill

The rehabilitation of Second Seven Dumpsite should be implemented with sanitary landfill system. The best method applicable to the dumpsite should be discussed, evaluated and determined through feasibility study in cooperation with experts of waste management including international cooperation agencies. In parallel with the rehabilitation work, social consideration should be made for waste pickers because they may lose their livelihood measures by the Project. For example, it is ensured that they can segregate recyclables in designated spaces.

In addition, a new landfill should be constructed before the existing dumpsite is fulfilled. As described in Section 12.8.2.3, area with 16 hectares should be acquired for the additional landfill. Separately a new landfill for the airport city project should be constructed according to the Project progress.

(4) [Basic Policy 4] Efficient Use of Resources in Industry

In this Master Plan, industrial developments in some areas are planned in Lae Urban, Yalu, and Nadzab areas. Each area has unique characteristic in terms of industry type. Eco-friendly industrial development could be accomplished by recycling industrial wastes so that the amount of wastes is not rapidly increased. The local level governments should make efforts to attract recycling firms to the Project Area and mutually cooperate with them for promoting the 3Rs activities.

(5) [Basic Policy 5] Capacity Development in Waste Management Sector

According to increase of population in the Project Area, the amount of solid waste generation may be rapidly increased. On the other hand, the budget allocated to the waste management division in local level governments is strictly limited. Current waste management services provided by Lae District are not efficiently conducted. For the accomplishment of more efficient collection and transportation services, basic study including “time and motion study” should be implemented.

Besides, monitoring capacity should be developed for recording and reporting the progress of several outcomes from implementation of new 3Rs activities. The capacity development should be supported by experienced organizations in early stage.

12.8.1.2 Development Goals and Target Effect Indicators

Development goals and target effect indicators in year 2025 and 2050 for evaluation of future development and confirmation of its outcomes are set as follows;

Table 12.8.1 Development Goals and Effect Indicators in year 2025 and 2050
(Solid Waste Management Sector)

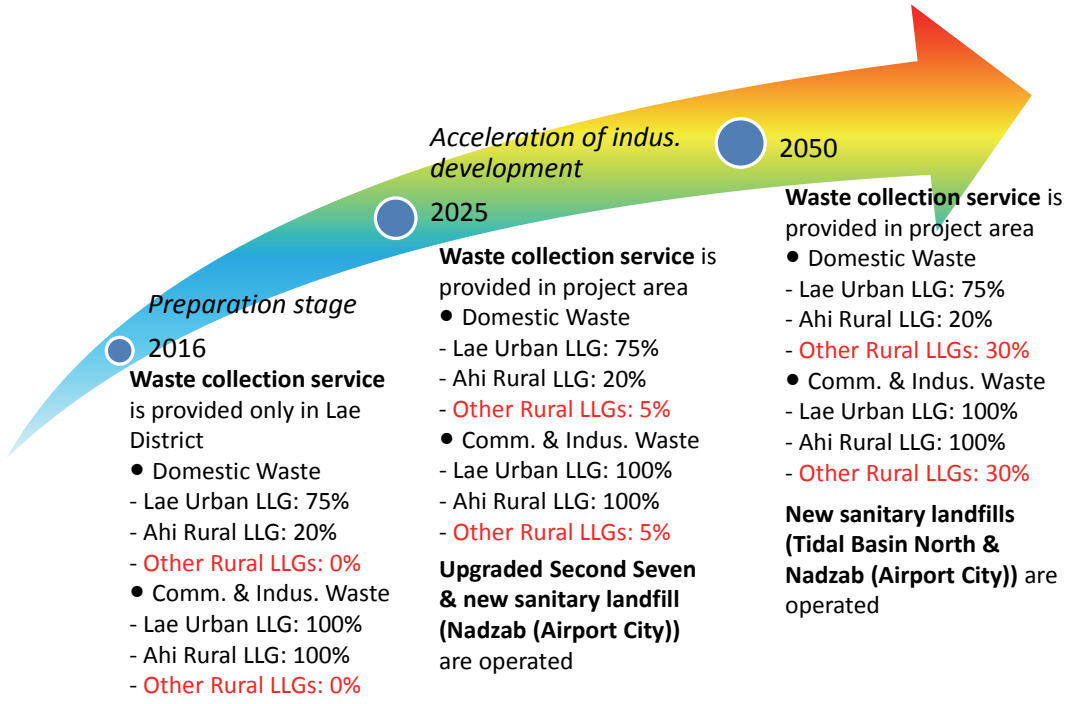
<table>
<tr><th>Development Goal</th><th>Effect Indicator</th></tr>
<tr><td>1) Quality living environment is created through collection and transportation of solid waste in the Project Area</td><td>Coverage rate of solid waste:
Domestic Solid Waste
<table>
<tr><th>District</th><th>LLG</th><th>2025</th><th>2050</th></tr>
<tr><td rowspan="2">Lae</td><td>Lae Urban</td><td>75%</td><td>75%</td></tr>
<tr><td>Ahi Rural</td><td>20%</td><td>20%</td></tr>
<tr><td>Huon Gulf & Nawaeb</td><td>Other Rural</td><td>5%</td><td>30%</td></tr>
</table>
(see Table 12.8.2)

Commercial and Industrial Solid Waste
<table>
<tr><th>District</th><th>LLG</th><th>2025</th><th>2050</th></tr>
<tr><td rowspan="2">Lae</td><td>Lae Urban</td><td>100%</td><td>100%</td></tr>
<tr><td>Ahi Rural</td><td>100%</td><td>100%</td></tr>
<tr><td>Huon Gulf & Nawaeb</td><td>Other Rural</td><td>5%</td><td>30%</td></tr>
</table>
(see Table 12.8.3)</td></tr>
<tr><td>2) Recyclables (metals/non-metals, glass bottles) are properly recycled.</td><td>Recycling rate:
<table>
<tr><th>District</th><th>LLG</th><th>2025</th><th>2050</th></tr>
<tr><td rowspan="2">Lae</td><td>Lae Urban</td><td>35%</td><td>80%</td></tr>
<tr><td>Ahi Rural</td><td>35%</td><td>80%</td></tr>
<tr><td>Huon Gulf & Nawaeb</td><td>Other Rural</td><td>27%</td><td>80%</td></tr>
</table>
(seeTable 12.8.10)</td></tr>
<tr><td>3) Organic waste are reduced through composting activity</td><td>Reduction rate:
<table>
<tr><th>District</th><th>LLG</th><th>2025</th><th>2050</th></tr>
<tr><td rowspan="2">Lae</td><td>Lae Urban</td><td>7%</td><td>20%</td></tr>
<tr><td>Ahi Rural</td><td>7%</td><td>20%</td></tr>
<tr><td>Huon Gulf & Nawaeb</td><td>Other Rural</td><td>6%</td><td>20%</td></tr>
</table>
(see Table 12.8.11)</td></tr>
<tr><td>3) Rehabilitation of existing dumpsite is conducted.</td><td>Target year of commissioning of rehabilitated Second Seven Dumpsite: year 2020 (see Figure 12.8.11)</td></tr>
<tr><td>4) Construction of new sanitary landfill</td><td>Required land with 16 ha is secured for post Second Seven Dumpsite in the Project Area and sanitary landfill is constructed in a phased manner. (see Figure 12.8.11)
Required land with 1.5 hectares is secured for sanitary landfill in Nadzab area. (see Figure 12.8.12)</td></tr>
</table>

Source: JICA Project Team

12.8.1.3 Development Scenario till 2025 and 2050

The development scenario of solid waste management sector aimed at year 2025 and year 2050 is shown in Figure 12.8.2.



Source: JICA Project Team

Figure 12.8.2 Development Scenario of Solid Waste Management in the Project Area

(1) Expansion of Collection Service Area

As described in Section 6.8.2, except for LULLG, no waste collection service is provided to residents and private companies. In Lae District, the service is provided only for residential area due to limitation of budget and human resources. The ratio of residential and settlement area is assumed to keep the current level in future due to the limitation of land in urban area. Regarding commercial and industrial area, it is assumed that the coverage rate is pegged at 100% in Lae District.

Regarding the other areas, a number of people would flow into settlement areas adjacent to Lae District in Huon Gulf and Nawaeb Districts according to the progress of industry development. In order to mitigate environmental and social impact concerning solid wastes in those areas, waste collection service should be expanded to those areas, especially high population density areas near Lae Distict, in near future. Under this reason, numerical target for waste collection coverage is set as shown in Table 12.8.2 and Table 12.8.3.

Table 12.8.2 Target of Service Coverage of Domestic Solid Waste

District	LLG	2016	2025	2050
Lae	Lae Urban	75%	75%	75%
	Ahi Rural	20%	20%	20%
Huon Gulf	Wampar Rural	0%	5%	30%
Nawaeb	Nabak Rural	0%	5%	30%
	Labuta Rural	0%	5%	30%

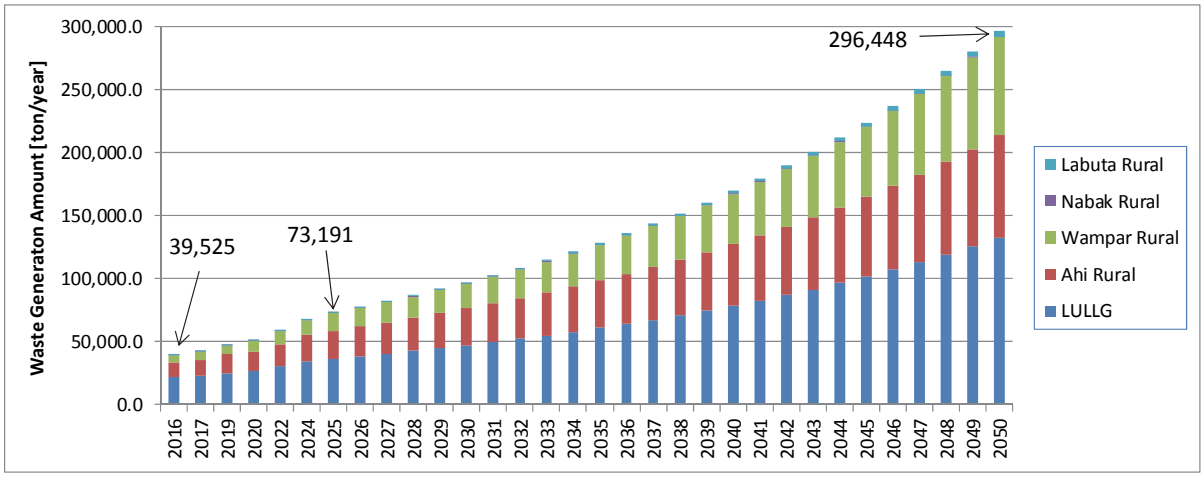
Source: JICA Project Team

Table 12.8.3 Target of Service Coverage of Commercial and Industrial Solid Waste

District	LLG	2016	2025	2050
Lae	Lae Urban	100%	100%	100%
	Ahi Rural	100%	100%	100%
Huon Gulf	Wampar Rural	0%	5%	30%
Nawaeb	Nabak Rural	0%	5%	30%
	Labuta Rural	0%	5%	30%

Source: JICA Project Team

The future estimation of solid waste generation amount in the Project Area from year 2016 to 2050 is shown in Figure 12.8.3.



Source: JICA Project Team

Figure 12.8.3 Future Amount of Solid Waste Generation in the Project Area

(2) Rehabilitation and Construction of Dumpsite

As to the final disposal site, official dumpsite operated by local government in the Project Area is Second Seven Dumpsite (open dumping) located in Lae Urban Area. Wastes are dumped in open space without compaction and waste pickers put fire on them indiscriminately. LULLG occasionally entrusts a contractor to organize those wastes with a bulldozer. This dumpsite has adverse impacts on environment and health of people. The lifetime of the dumpsite is unknown as no management and monitoring is conducted by government.

First of all, this dumpsite should be rehabilitated to a sanitary landfill by year 2025 so that the adverse impact is mitigated with lower cost. If the capacity of the rehabilitated dumpsite is not enough for the waste collected in the Project Area, additional landfill(s) should be constructed in appropriate area(s).

In order to accomplish the above target aimed at 2050, the master plan of waste management sector from year 2016 to year 2025 is developed.

12.8.2 Solid Waste Mangement Plan

12.8.2.1 Forecast of Waste Management Plan

(1) Basis of Demand Estimation

The basis of estimation for solid waste generation is shown in Table 12.8.4.

Table 12.8.4 Basis of Estimation for Solid Waste Generation

Category	Type of Waste	Basis of Estimation for Demand Projection
Solid waste (municipal waste)	Household waste (domestic waste)	Based on population growth rate and unit generation rate (UGR)
	Other municipal waste (commercial, industrial and public waste)	Based on GRDP growth rate (Momase Region)
Hazardous waste	Infectious wastes from medical facilities	Based on population growth rate

Source: JICA Project Team

(2) Future Population

Future population is estimated for three scenarios in Section 9.2 by JICA Project Team.

(3) Physical Composition of Municipal Waste

The physical composition of domestic waste and commercial & industrial waste is assumed in Section 6.8.2, (1). Generally the composition of domestic waste changes according to the economic

growth due to changes of people's life style. For example, the composition rate of organic waste is reduced according to the economic growth. The ratio of organic waste in the Project Area is pegged at 40%. This figure is comparatively less in spite of the economic status in the area. Therefore, this figure is considered to keep from year 2016 to year 2025.

Table 12.8.5 Physical Composition of Domestic Solid Waste

Category	Physical Composition (2016 - 2025)
Organic waste (kitchen waste, grass, leaves, woods)	40%
Recyclables (paper, metals/non-metals, glass, PET bottles)	42%
Others	18%

Source: JICA Project Team

(4) Waste Diversion

As of 2016, the segregation of recyclables is generally implemented in residential/settlement areas, commercial/industrial areas and official/unofficial dumpsites. As described in Section 6.8.4, (2), several material recovery companies are operating their factories for metals, non-metals, and so on. Since the collection is conducted voluntarily by citizens or private companies, the recycling rate is low. Regarding organic waste, no treatment action such as composting is conducted in the Project Area.

(5) Projection of Domestic Waste

1) Projection Method

The future amount of domestic waste is calculated by multiplying the anticipated unit generation rate (UGR), the Projected population and the percentage of waste collection coverage.

$$DWi = UGRi * POPi * WCCi$$

DWi : domestic waste amount in year *i*
UGRi : unit generation rate in year *i*
POPi : population in year *i*
WCCi : waste collection coverage (%) in year *i*

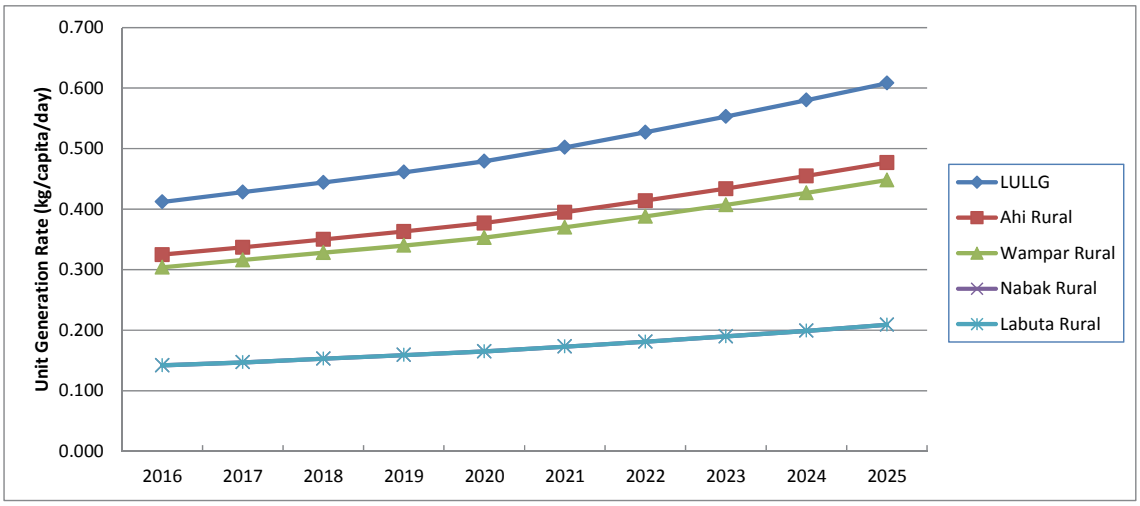
2) Unit Generation Rate

UGR is set for each local level government based on the household monthly income level. It is assumed that the future UGR would change according to GRDP (Gross Regional Domestic Product) growth rate in Momase Region as shown in Table 12.8.6 and Figure 12.8.4.

Table 12.8.6 Unit Generation Rate of Domestic Waste

District	LLG/Rural	2016	2020	2025
GRDP per capita growth rate (Momase Region)		3.8%	4.9%	2.9%
Lae	LULLG	0.412	0.479	0.608
	Ahi Rural	0.325	0.377	0.477
Huon	Wampar Rural	0.304	0.353	0.448
Nawaeb	Nabak Rural	0.142	0.165	0.209
	Labuta Rural	0.142	0.165	0.209

Source: Waste Management Division, NCDC (2009-2014) and JICA Project Team



Source: Waste Management Division, NCDC (2009-2014) and JICA Project Team

Figure 12.8.4 Unit Generation Rate of Domestic Waste

(6) Projection of Other Municipal Waste

1) Projection Method

The future amount of other municipal waste is estimated under the assumption that the waste from commercial and industrial areas would increase according to the economic growth. The amount is calculated by multiplying the amount of the waste generated in previous year, the percentage of GRDP growth rate and the percentage of waste collection coverage rate.

$$OMWi = OMW_{(i-1)} * (1+Ri) * WCCi$$

OMWi	: other municipal solid waste amount in year *i*
Ri	: growth rate of GRDP (%) in year *i*
WCCi	: waste collection coverage (%) in year *i*

(7) Projection of Infectious Waste

1) Projection Method

The future amount of infectious waste generated from medical facilities is projected based on the population growth as same as domestic waste. As of 2016, existing incinerator for infectious waste is situated at Angau Hospital. Actually there are few medical facilities to be able to bring their waste to the hospital.

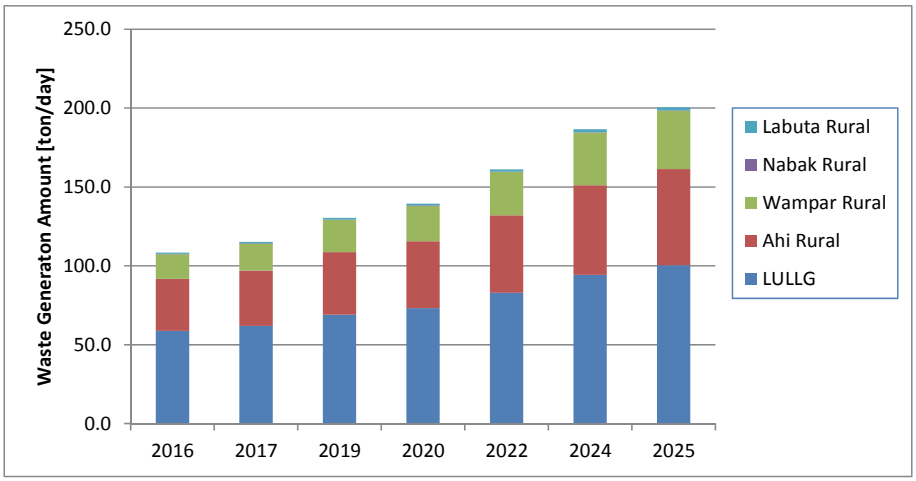
The amount of infectious waste is calculated by multiplying infectious waste amount in previous year and percentage of population growth rate.

$$IWi = IW_{(i-1)} * (1+PRi)$$

IWi	: infectious waste amount in year *i*
PRi	: growth rate (%) of population (Momase Region) in year *i*

(8) Future Amount of Municipal Solid Waste Generation

Future amount of municipal solid waste generation in the Project Area is shown in Figure 12.8.5. The future amount is estimated to be 108 tons/day in year 2016 and 200 ton/day in year 2025.



Source: JICA Project Team

Figure 12.8.5 Future Amount of Solid Waste Generation in the Project Area

(9) Capacity Demand for Final Disposal Site without 3Rs Activities

Since the situation of waste management service in LULLG and the other areas (Huon Gulf and Nawaeb Districts) are quite different, capacity demand for final disposal site is estimated separately.

1) Lae Urban Local Level Government

The capacity demand of the final disposal site is calculated under the following conditions;

a) Coverage rate of waste collection service

- Waste collection service is provided only for residential area. Settlement area is not covered.
- Land use rate of residential and settlement area is assumed to keep the current level in future.
- As domestic waste in residential area is collected and disposed of at dumpsite by LULLG in principle, it is assumed that all of the waste generated from residential area has already been collected by the government.

b) Self-treatment

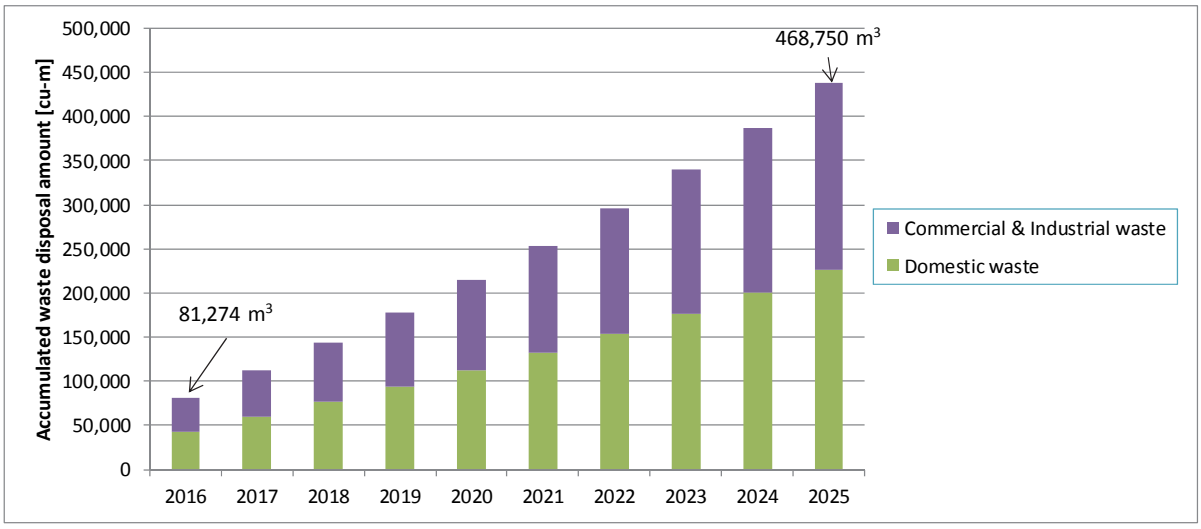
- People living in settlement areas ordinarily burn their burnable waste in their estates and dump it in dug pits and cover with soil, or disposed of waste without any treatment in the river, etc.

c) Waste diversion

- Although recovery and recycling activity is actually conducted for aluminium cans and glass bottles, such activity is not taken into account here.

d) Bulk density of waste at final disposal site: 0.8 ton/cubic metres

The total capacity of the final disposal site (Second Seven Dumpsite) is unknown. If the solid waste is collected and disposed of at the dumpsite without 3Rs activities, the required capacity of the dumpsite is estimated to be 468,750 cubic metres in year 2025 as shown in Figure 12.8.6.



Source: JICA Project Team

Figure 12.8.6 Accumulated Waste Disposal Future Amount in Lae District

2) The Other Areas (Huon Gulf (Wampar Rural LLG) and Nawaeb (Nabak and Labuta Rural LLGs))

There is no official dumpsite in this area as of year 2016. Besides, waste collection service is not provided by local level government due to limitation of budget. Therefore the estimation of capacity demand for final disposal site is made from the year when the waste collection service is provided by local level government. The coverage rate is pegged as described in Table 12.8.2 and Table 12.8.3.

To dispose of the solid waste generated from this area, construction of a new sanitary landfill is considered. If the new sanitary landfill is not constructed, Second Seven Dumpsite would be used for the wastes instead.

The capacity demand of final disposal site is calculated under the following conditions;

a) Coverage rate of waste collection service

- There is no residential area in Huon Gulf and Nawaeb Districts. All of the lands are villages or settlement areas.
- It is assumed that waste collection service is provided from year 2021. The coverage rate is pegged to increase by 1% every year.
- Target coverage rate is pegged as 5% in year 2025.
- Waste collection service is to be started in accordance with relevant law which is proposed in Section 12.8.2.4. The collection area is determined by local level government accordingly.

b) Self-treatment

- Residents living in rural areas ordinarily burn their burnable waste in their estates and dump it in dug pits and cover with soil, or disposed of the waste without any treatment in river, etc.

c) Waste diversion

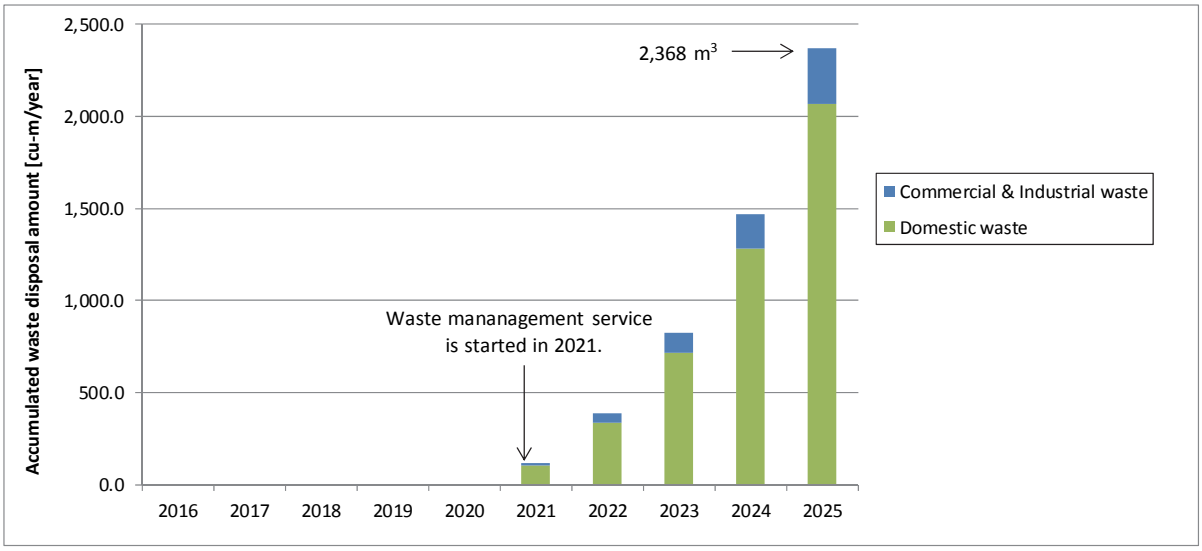
- Although recovery and recycling activity is currently conducted for aluminium cans and glass bottles to a limited extent, such activity is not taken into account here.

d) Period of no waste collection

- Current situation that no waste collection is conducted would continue till year 2020.

e) Bulk density of waste at final disposal site: 0.8 ton/cubic metres

If the solid waste is collected and disposed of at dumpsite without 3Rs activities, the required capacity of the dumpsite is estimated to be 2,368 cubic metres in year 2025 as shown in Figure 12.8.7.



Source: JICA Project Team

Figure 12.8.7 Accumulated Waste Disposal Amount in the Other Areas

12.8.2.2 Demand for Waste Collection and Final Disposal with 3Rs Activiries

(1) Scenario Setting

1) Selection of Items for 3Rs Activities

In PNG, no waste management plan is developed by national, regional, district, and local level governments as of year 2015. If this situation is continued on solid waste management, some adverse impacts on environment and human health should occur undoubtedly, which includes air and ground water pollutions at dumpsites, littered refused in river/stream/seashore, and nuisance due to smoke by waste combustion.

Considering the potential effects of 3Rs (reduce, reuse and recycling) in the demand analysis of waste amount, type of wastes for 3Rs activities are considered. Current situation of recovery and recycling markets are shown in Table 12.8.7. These markets are concentrated in Lae District, thus recyclables are usually transported from other areas to Lae Urban Area.

Table 12.8.7 Existing Recovery and Recycling Market in the Project Area

Waste Type	Target Item for 3Rs	Existing Market		Current Status
		Lae District	Other Districts	
Household (domestic waste)	Organic waste (kitchen waste, grass, leaves, woods)	-	-	Organic waste and paper are disposed of at dumpsite or in the ground, river, etc., or burn in open space
	Paper	-	-	
	Metals/non-metals	√	√	Aluminum cans of drinks are segregated and sold to market.
	Glass	√	-	Bear bottle (SP) is collected and reused by SP.
	PET bottle	-	-	No market for recycling
	Other plastics	-	-	Other plastics are disposed of at dumpsite. Biodegradable plastic bag is adopted at supermarkets.
Other municipal waste (commercial and industrial)	Organic waste (kitchen waste, grass, leaves, woods, market waste)	-	-	Organic waste and paper are disposed of at dumpsite or in the ground. Market waste is disposed of at each estate except for Lae Main Market.
	Paper	-	-	
	Metals/non-metals	√	√	Aluminium cans of drinks are segregated and sold to market.
	Glass	√	-	Bear bottle (SP) is collected and

Waste Type	Target Item for 3Rs	Existing Market		Current Status
		Lae District	Other Districts	
				reused by SP.
	PET bottle	-	-	No market for recycling
	Other plastics	-	-	Other plastics are disposed of at dumpsite.

Source: JICA Project Team

a) Metals/non-metals and glass bottles

Material recovery of metals/non-metals and glass bottles (SP Brewery) is conducted in Lae District. According to the increase of demand of these markets including the other beverage companies due to the economic growth in this area, more private companies are expected to conduct this "reuse" activity. Materials collected and traded today are expected to keep being recycled or reused, which include metals, non-metals and glass bottles. In addition, materials which are not recycled today such as tin can for food like processed fish would be treated in future.

b) Papers, PET bottles and other plastics

Recyclables having no recycling market such as papers, PET bottles and other plastics needs certain period till recycling market is developed. For private recycling companies, adequate volume of those recyclables should be collected stably from a profitability standpoint.

If private companies conduct material recycling of these recyclables in this area, it requires huge investment in initial machine installment, and operation and maintenance. For instance, as to recycling of PET bottles and other plastics requires high cost for equipment such as crushing machines, washing equipment, compaction and veiling machine. Recycling of used paper requires equipment with high technology, chemicals and an appropriate wastewater treatment plant.

Considering these conditions, it might be preferable for private companies to collect, compact and pack with baling machine for exporting those materials to overseas, e.g. Japan, China, Indonesia, Australia, etc. in first stage.

c) Organic waste

Organic wastes such as kitchen waste, grass, leaves, wood and market wastes can be composted and utilized in farms and gardens. Currently there is no composting plant in PNG. If organic amount can be reduced through new activity such as composting, more wastes can be collected in current collection capacity and the coverage could be increased. Besides, if the amount of organic waste carried into the dumpsite is decreased, adverse environmental impacts such as odour due to rotten organic waste and generation of bugs could be considerably mitigated. Other than these effects, the emission of methane gas from landfill through anaerobic fermentation reactions could be decreased as well.

2) Implementation Plan of 3Rs Activities

According to the above considerations, 3Rs activities conducted in the Project Area are planned as shown in Table 12.8.8 and Table 12.8.9.

"Action-I" is to make the best use of the existing recovery and recycling facilities operated by private firms and increase the waste diversion rate in cooperation with local governments, private firms and citizens through wide-range dissemination activity.

"Action-II" is to reduce the organic waste and make organic fertilizer. First two years are set as period of pilot project in association with research institutes such as National Agriculture Research Institute (NARI), schools such as Malahang Technical High School and local farmers. This project should be cooperated by waste generators such as local markets to provide their organic waste constantly in certain period. Produced compost is analyzed and applied to test farms for evaluating the quality. Based on the result, actual implementation period is started from year 2021. Firstly composting activity is implemented in houses. The organic fertilizer is utilized in their gardens and

farms. Secondly, according to the progress of industry development plans of "agro products consolidating depot" and "food processing", private firms of compost manufacturing are expected to start their business.

"Action-III" depends on emergence of recycling markets of used paper, PET bottle and other plastics. Considering the size of population in the Project Area, when such private companies are established and get started on their business in the Project Area is uncertain.

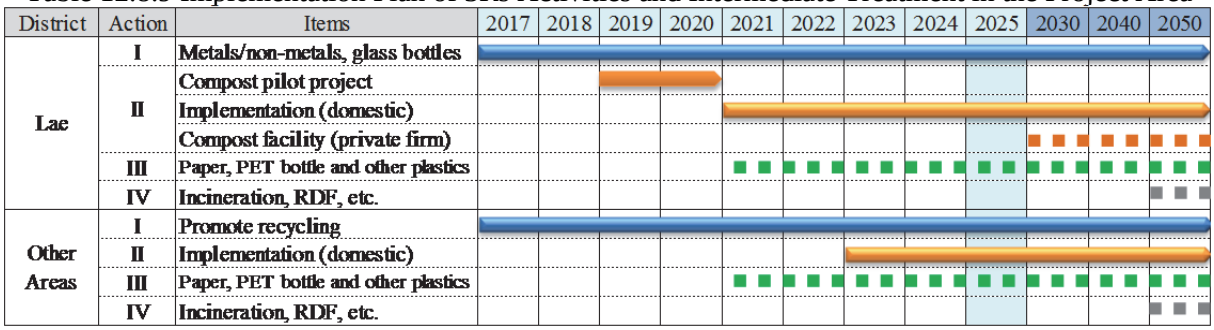
Action-IV is the adoption of the waste treatment method with high technology. Solid waste incineration plant requires high investment and high engineering skills to operate and maintenance. RDF (refuse-derived fuel) is produced by solid waste such as paper, plastics, wood and rubber with high calorific value. RDF can be utilized as an alternative fuel instead of fossil fuel such as oil and coal at paper mill, cement factory, etc. As of 2016, there is no company which can utilize the RDF in the Project Area.

Table 12.8.8 Phased 3Rs Activities and Intermediate Treatments in the Project Area

Action	3Rs Activities	Target Waste/Material
Action-I	To promote the recycling by making the best use of existing recovery and recycling facilities in the Project Area.	Metals/non-metals, glass bottles
Action-II	To promote a new method to reduce organic waste through segregation and intermediate treatment by conducting a pilot project followed by actual implementation.	Organic waste
Action-III	To recycle other materials only after recycling market is developed in the Project Area	Paper, PET bottle and other plastics
Action-IV	To install high technology facility such as an incineration plant, RDF (refuse-derived fuel) plant, etc.	Paper, plastics, wood, rubber, and other burnable wastes

Source: JICA Project Team

Table 12.8.9 Implementation Plan of 3Rs Activities and Intermediate Treatment in the Project Area



Source: JICA Project Team

a) [Action-I and Action-II] Numerous Target of 3Rs Activities and Intermediate Treatment

There is no data about current recycling rate (%) in the Project Area. The recycling rate of metals/non-metals and glass bottles in Lae District is obviously higher than that in other areas due to the existence of recycling markets in Lae Urban Area. The numerous target of recycling activity is set as shown in Table 12.8.10. The amount of recyclables is reflected by coverage rate in each area (see Section 12.8.1.3).

Table 12.8.10 Target of 3Rs Activities (Recyclables) in the Project Area

Type of Material		2017	2020	2025	2035	2045	2050
Lae District							
Recyclables (Metals/non-metals, glass bottles)	ton/day	1.6	2.3	4.2	10.1	20.8	29.2
	Target	20%	26%	35%	53%	71%	80%
Other Areas							
Recyclables (Metals/non-metals, glass bottles)	ton/day	0.0	0.0	0.1	0.9	4.5	8.9
	Target	10%	16%	27%	48%	69%	80%
Total	ton/day	1.6	2.3	4.3	11.0	25.3	38.1

Source: JICA Project Team

Regarding organic waste, pilot project of composting would be conducted in Lae District from year 2019 to year 2020. After the period, actual implementation for domestic waste would be started from year 2021. On the other hand, in the other areas the implementation for domestic waste is to be started in year 2023 based on the result of the pilot project done in Lae District. The amount of organic waste is reflected by coverage rate in each area (see Section 12.8.1.3

Table 12.8.11 Target of Intermediate Treatment (Organic Waste) in the Project Area

Type of Waste		2017	2020	2021	2022	2023	2024	2025	2035	2045	2050
Lae District											
Organic Waste	ton/day			1.5	1.9	2.1	2.6	2.8	8.0	19.3	29.9
	Target			5%	6%	6%	7%	7%	12%	17%	20%
Other Areas											
Organic Waste	ton/day					0.0	0.0	0.0	0.9	4.0	8.4
	Target					5%	6%	6%	11%	16%	20%
Total	ton/day			1.5	1.9	2.1	2.6	2.8	8.9	23.3	38.3

Source: JICA Project Team

b) [Action-III] Potential Market Size of Paper, PET bottle and other Plastics

As to paper, PET bottle and other plastics, the timing of these recycling markets to be developed in the Project Area is unclear. However the generation volume of these materials would rapidly increase as shown in Table 12.8.12 and Figure 12.8.8. Since especially the amount of paper is anticipated to show rapid increase in commercial and industrial area, private sector should make their effort to reduce, reuse and recycle used papers.

Used Paper

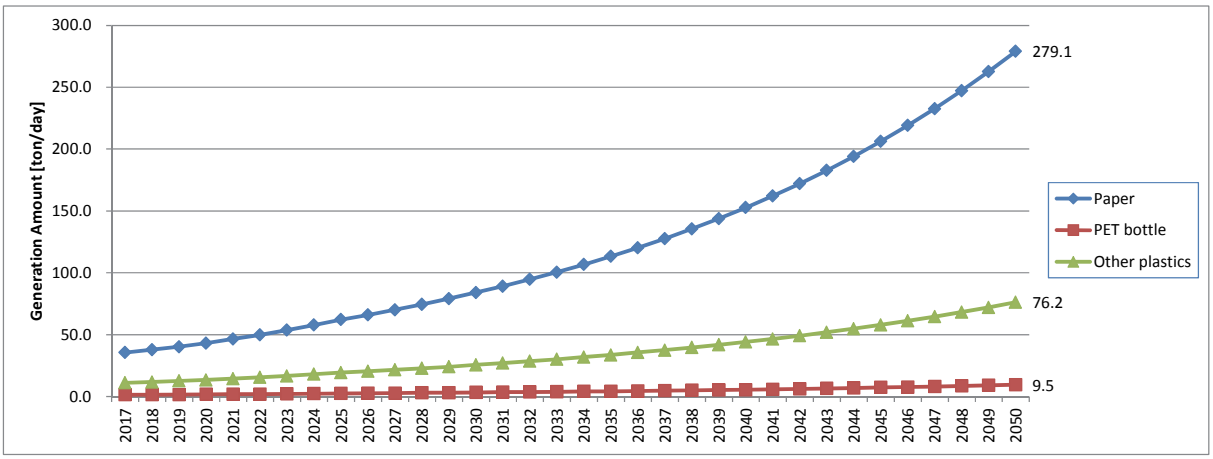
Recycling market of used paper is normally seen in developed countries. The simplest process of recycling used paper is collecting by type of paper, compacting, packing by baling machine, and exporting them. The point is how much used paper they can collect efficiently and economically. In Japan, popular collection method is called “group resource collection system”. The collection is conducted by local groups concerning primary school, children, local social groups, etc. Residents generally put used papers at the waste transfer stations near their houses on designated dates. Then local groups go around the collection route, pick them up by their trucks and sell them to resource collection companies. According to the market development progress, those collection methods should be discussed among local level governments and local groups.

Table 12.8.12 Future Amount of Paper, PET Bottle and Other Plastics in the Project Area

(unit: ton/day)

Type of Material	2017	2020	2025	2035	2045	2050
Lae District						
Paper	30.6	36.7	51.8	91.8	163.4	219.4
PET bottle	1.2	1.4	2.0	3.1	5.2	6.6
Other plastics	9.3	11.0	15.4	25.5	41.7	53.7
Huon and Nawaeb Districts						
Paper	4.9	6.4	10.4	21.5	42.8	59.7
PET bottle	0.2	0.3	0.4	1.0	2.1	2.9
Other plastics	1.8	2.4	3.9	8.1	16.2	22.5
Project Area						
Paper	35.5	43.1	62.2	113.3	206.2	279.1
PET bottle	1.4	1.7	2.4	4.1	7.3	9.5
Other plastics	11.1	13.4	19.3	33.6	57.9	76.2

Source: JICA Project Team



Source: JICA Project Team

Figure 12.8.8 Future Amount of Paper, PET bottle and Other Plastics in the Project Area

(2) Amount of Wastes with Effect of 3Rs Activities and Intermediate Treatment

As described above, Phase-III and Phase-IV have uncertainty in its implementation. Therefore the amount of wastes from year 2017 to 2025 is calculated for Phase-I and Phase-II.

1) Lae District

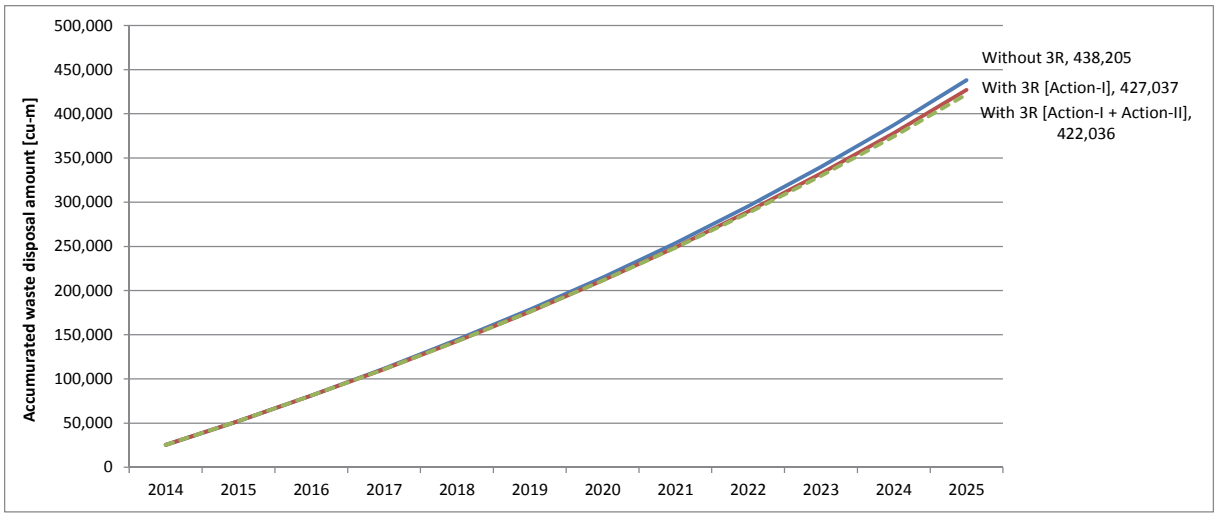
The effect of 3Rs activities and intermediate treatment in Lae District is shown in Table 12.8.13 and Figure 12.8.9. In year 2025, the effect of the activities to total disposal amount seems to be very limited.

Table 12.8.13 Accumulated Waste Disposal Amount with 3R Activities and Intermediate Treatment in Lae District

(unit: m^3)

Year	2017	2020	2025	2035	2045	2050
Without 3R	111,837	214,821	438,205	1,136,663	2,357,830	3,285,340
With 3R [Action-I]	111,108	211,283	427,037	1,093,045	2,243,947	3,113,203
Reduction rate	0.7%	1.6%	2.5%	3.8%	4.8%	5.2%
With 3R [Action-I + Action-II]	111,108	211,283	422,036	1,063,334	2,151,531	2,962,971
Reduction rate	0.7%	1.6%	3.7%	6.5%	8.7%	9.8%

Source: JICA Project Team



Source: JICA Project Team

Figure 12.8.9 Accumulated Waste Disposal Amount with 3Rs Activities and Intermediate Treatment in Lae District

2) The Other Areas (Huon Gulf (Wampar Rural LLG) and Nawaeb (Nabak and Labuta Rural LLGs))

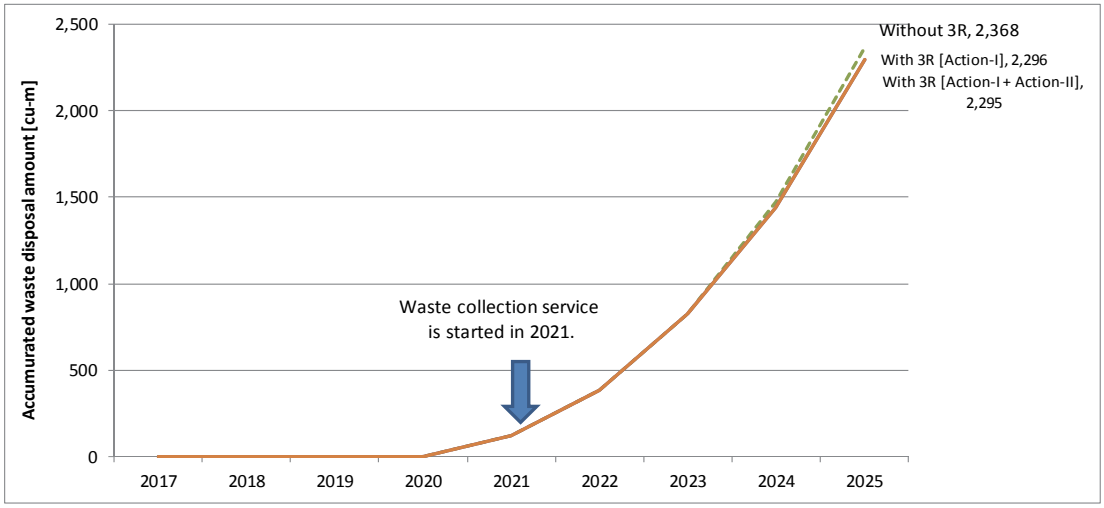
The effect of 3Rs activities and intermediate treatment in the other areas is shown in Table 12.8.14 and Figure 12.8.10. Since the population in this area is estimated to show rapid increase rather than Lae District, these activities would be effective in reducing the waste amount at dumpsite.

Table 12.8.14 Accumulated Waste Disposal Amount with 3R Activities and Intermediate Treatment in the Other Areas

(unit: m^3)

Year	2021	2022	2023	2024	2025	2035	2045	2050
Without 3R	120	386	825	1,473	2,368	32,910	150,206	278,016
With 3R [Action-I]	120	386	825	1,437	2,296	30,830	136,338	248,344
Reduction rate	0.0%	0.0%	0.0%	2.4%	3.0%	6.3%	9.2%	10.7%
With 3R [Action-I + Action-II]	120	386	825	1,436	2,295	28,968	123,999	221,769
Reduction rate	0.0%	0.0%	0.0%	2.5%	3.1%	12.0%	17.4%	20.2%

Source: JICA Project Team



Source: JICA Project Team

Figure 12.8.10 Accumulated Waste Disposal Amount with 3Rs Activities and Intermediate Treatment in the Other Areas

(3) Future Amount of Infectious Wastes

The amount of infectious waste generated from medical facilities in the Project Area is estimated as shown in Table 12.8.15. As of year 2016, only a few medical facilities have their infectious wastes treated by incinerator. The amount of incineration residue was calculated under assumption that all of the generated infectious wastes in the Project Area would appropriately be incinerated.

Table 12.8.15 Future Amount of Infectious Waste in the Project Area

(ton/year)

Category	Type of Facility	2017	2020	2025	2035	2045	2050
Before Incineration							
Infectious Waste	Angau Hospital	131	143	163	213	278	318
	Health center, clinic, aid-post	120	129	148	193	251	287
Total		251	272	311	406	529	605
After Incineration (incineration residue)							
Infectious Waste	Angau Hospital	7	7	8	11	14	16
	Health center, clinic, aid-post	6	6	7	10	13	14
Total		13	13	15	21	27	30

Note: It is assumed that the amount of infectious waste is reduced by 95% after incineration treatment.
Source: JICA Project Team

12.8.2.3 Demand for Waste Collection and Final Disposal with 3Rs Activities

(1) Southern Area Centring on Lae District

According to the growth of population and economy, solid waste amount will increase rapidly as described in Section 12.8.1.3. In addition to Lae District area, adjoining areas in Wampar rural LLG (Huon Gulf District), Nabak and Labuta rural LLTs (Nawaeb District) should be provided with such services, where industrial development is planned in this Master Plan and a number of people would come to settle in.

From environmental and social point of view, the existing dumpsite (Second Seven Dumpsite) should be rehabilitated in environment-friendly manner. In year 2015, Baruni Dumpsite in Port Moresby was rehabilitated with Fukuoka Method. This system has already been applied to a lot of dumpsite all over the world.

In parallel with the rehabilitation work, an intermediate treatment facility for segregation process should be planned for waste pickers from social point of view.

The lifetime of the rehabilitated Second Seven Landfill with 2.5 hectares (landfill area) is estimated to be about 9 years. Considering the associated facilities such as leachate pond, administration building and parking for heavy machines, another 1 ha is necessary. In total 3.5 hectares should be ensured at the site.

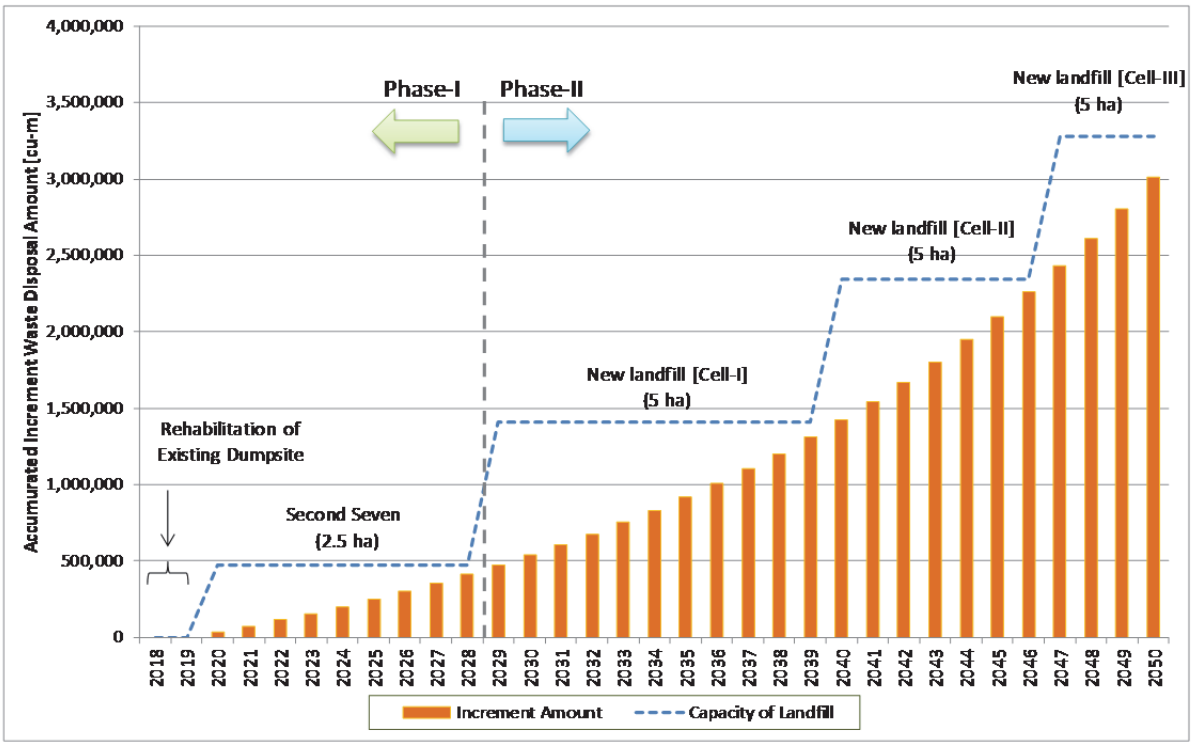
For the period after closure of Second Seven Landfill, additional landfill construction needs to be planned in a phased manner as shown in Table 12.8.16 and Figure 12.8.11. After rehabilitated Second Seven Landfill is fulfilled up to its capacity, transport direction of solid waste would be shifted to the new sanitary landfill site constructed. As the candidate site for the facility, hinterland of Tidal Basin (Tidal Basin North) with 15 hectares (landfill area) is projected. As the associated facilities require roughly 1 ha, land with 16 ha in total should be ensured at the site.

The areas of Second Seven and Tidal Basin North have flat terrain. The solid waste would be pressed by heavy machine to one meter height and covered with 20 cm of soil. The waste would be piled up to 15 to 20 meter at final stage.

Table 12.8.16 Phased Plan for Rehabilitation and Construction of Landfill in the Project Area

Phase	Plan	Landfill	Total area	Construction Period	Remarks
Phase-I	To rehabilitate the existing dumpsite with semi-aerobic sanitary landfill system	2.5 hectares	3.5 hectares	2018 – 2019	In parallel, the existing open dumpsite is organized and finalized by covering with soil.
Phase-II	To construct new sanitary landfills	15 hectares	16 ha	After 2025	Tidal Basin North area

Source: JICA Project Team



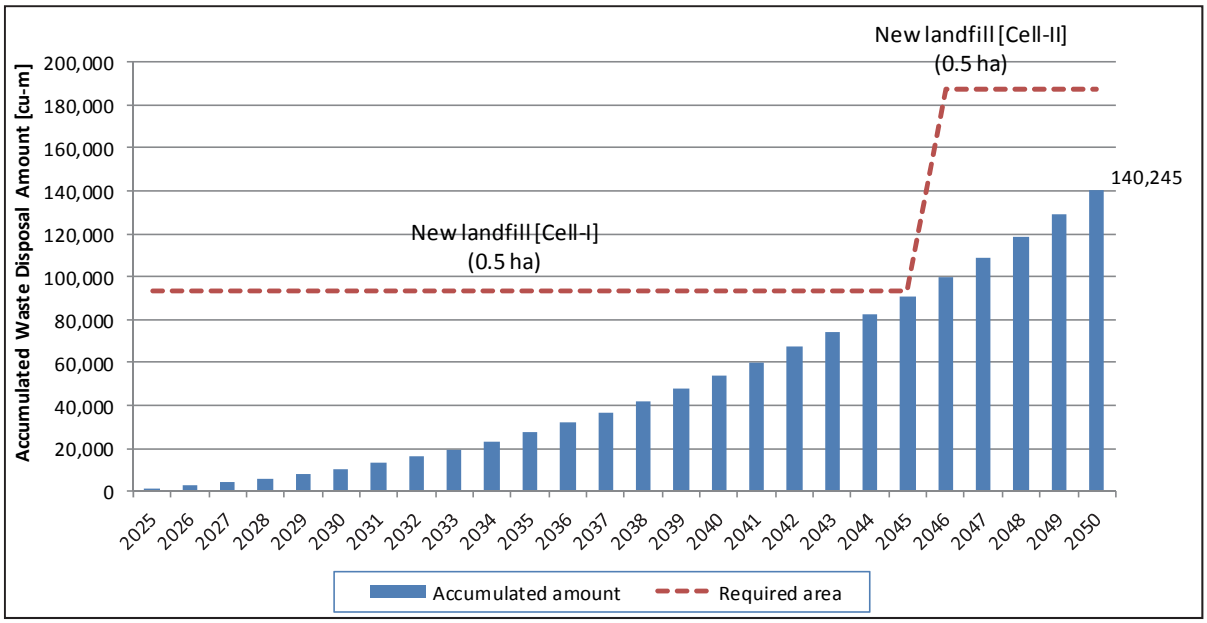
Source: JICA Project Team

Figure 12.8.11 Phased Plan for Rehabilitation and Construction of Landfill in the Project Area (except Nadzab Airport City)

(2) Northern Area Centreing on Nadzab Airport City

An airport city development is planned around existing Nadzab Airport till year 2025. Since this area is too far from Lae Urban Area to bring the wastes generated in this area to Lae Urban Area, new sanitary landfill should be prepared separately for the airport city. In the area, commercial, industrial and academic facilities will be constructed and the increment population would increase up to 4,000 in year 2025 and 22,000 in year 2050. The amount of municipal solid waste is estimated to be 2.4 ton/day in year 2025 and 24.0 ton/day in year 2050 under assumption that people live urban lifestyle. Required capacity of final disposal site is estimated to be approximately 140,000 cubic metres until year 2050, which requires a sanitary landfill with 0.8 hectares (landfill area). Just to be on the safe side, landfill area with 1.0 hectare should be secured. As the associated facilities require about 0.5 hectares, land with 1.5 hectares in total should be ensured at the site. The required land may be found out in customary lands and acquired in early stage.

Besides, separate collection system for the area should be prepared by local level government. This project should be spatially detailed in the urban planning.



Source: JICA Project Team

Figure 12.8.12 Construction of Landfill for Airport City around Nadzab Airport

12.8.2.4 Development Plan

(1) Development Plan till year 2025

The following strategies are proposed for achieve the basic policies till year 2025.

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

1) Establishment of Associated Laws, Policies and Regulations

Execution of laws of waste management is very effective to promote the proper waste collection, treatment and fee collection as well as enforcing strong regulation to illegal dumping, etc. LULLG is the only local level government establishing and executing by-laws of waste management. Nevertheless, the clauses stipulated in by-laws and relevant laws are not necessarily respected by citizens today. For instance, Public Nuisance Law (amended), 1998 prohibits burning any substance on land, building, premises, roads or streets, however this behaviour is usually seen in both urban and rural areas.

To accomplish the sector vision, establishment of associate law, policies and regulations is essential.

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

It is proposed to establish broad-based by-laws on solid waste management applied to the Project Area. The proposed items of the by-laws are shown in Table 12.8.17.

Table 12.8.17 Proposed Items of By-laws

Item	Description
Targeted wastes	Municipal solid waste, hazardous wastes (medical and industrial), disaster debris
Fees	Garbage fees, payment of fees
Receptacles	Receptacles of garbage at houses, commercial and industrial areas, and public areas, etc.
Provision of collection services	Type of services provided by local governments

Item	Description
Proper treatment	Segregation by generators, incineration of hazardous wastes (infectious wastes)
Offence and penalty	
Prohibited manner	Combustion of wastes, throwing waste to drainage, river, sea, etc.
3Rs activities	Promotion of 3Rs activities and eco-friendly lifestyle

Note: *Hazardous wastes include chemical, quarantine (port and airport), radio-active and contagious wastes.
Source: JICA Project Team

b) Policies and Regulations to Promote 3Rs Activities

Material recovery and recycling are being carried out by private firms in Lae Urban Area. Taking into account budgetary constraints of local level governments, it is recommended that private sectors conduct the activities continuously as it is today. Usually residents are segregating the recyclables (cans and glass bottles) at their houses and waste pickers are collecting recyclables at dumpsite and carry the recyclables into the private firms for sale. In order to support and promote these activities by local level governments, policies and regulations should be discussed and established as early as possible. The solid structure supported by such policies and regulations will encourage the recovery and recycling market to be promoted and developed faster.

Metal/non-metal and Glass Bottles

In order to encourage people to do the 3Rs activities more proactively, subsidy systems might be effective as one of the options. If government assists recovery and recycling firms by adding some money on their purchasing price when they purchase recyclables from citizens, it becomes intensive for citizens to do the 3Rs activities. At the same time, such firms may collect more recyclables efficiently from citizens. Besides, recycling rate would increase in short time. Even if this subsidy system is applied in short period, people should get familiar with these actions.

PET Bottle and Used Paper

As described in Section 12.8.2.2, there are recycling markets of PET bottle and used paper in the world. In order to promote the collection of such materials, it would be effective to establish a policy in the Project Area. Once such materials are collected to some extent, private firms should invest in those businesses soon in the Project Area.

The policies and regulations of 3Rs activities are proposed in Table 12.8.18.

Table 12.8.18 Proposed Policies and Regulations of 3Rs

Policies and Regulations	Description
Recycling promotion law	Setting the target materials and its target recycling rate in certain period. Description of expected responsibility of residents, governments and private sectors. Prioritization of each treatment measures (3Rs)
Recycling policy	Recycling promotion of used paper and PET bottle
Green procurement	Local governments procure eco-friendly products (paper, vehicle, etc.)

Source: JICA Project Team

2) Promotion of 3Rs Activities

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

The amount of solid waste generation can be easily reduced through 3Rs activities at generation sources. Currently local governments have no intermediate facility for recycling materials and are not providing the collection or transportation services for recyclables due to limitation of budget, human resources, technical skills and so on. People usually segregate those recyclables (metal/non-metal and glass bottle) and sell them to material recovery firms or brewery company directly or indirectly via local buyers. Though there is no official data about recycling rate, the rate seems to be low level in rural areas because such recovery and recycling firms are concentrated in Lae Urban Area.
From economic point of view, preferable way for promoting 3Rs may be to make the best use of the existing recovery and recycling routes provided by private firms. Local level governments should prepare promotion documents and implement dissemination activity at a lot of sites where

people gathers such as public offices, schools, shops, churches, etc.
Commercial and industrial companies should aggressively participate in the 3Rs activities by segregating recyclables at generation sources as well.
Expected roles of each concerned party and resident are shown in Table 12.8.19.

Table 12.8.19 Expected Roles of Parties/Resident

Party/Resident	Expected Roles	Location
Local governments	Dissemination activity (exhibiting poster, issuing leaflet, etc.)	Public spaces, city halls, schools, churches, shops, business associations, etc.
Residents	Segregation of recyclables and sale to recovery and recycling firms	Houses, public spaces, etc.
Commercial and industrial firms	Segregation of recyclables and sale to recovery and recycling firms	Offices, factories, etc.
Recovery and recycling firms	To purchase recyclables for proper price. To increase items of materials.	Recycling factories

Source: JICA Project Team

b) Practice of 3Rs Activities in Projected Industrial Parks

As described in Chapter 11, industrial development projects are planned as shown in Table 12.8.20. Those 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 3Rs activities should be proposed according to each project type.

Table 12.8.20 Industrial Development Projects

	Project Title	Proposed Location
1	Metal working industry development centre	Kamukumung (Ahi Rural)
2	Wood working industry development centre	Yalu industrial park (Wampar Rural)
3	Nurturing of entrepreneurs through comprehensive development scheme (Industrial vitalization cluster)	Yalu industrial park (Wampar Rural)
4	Setting up of agro products consolidating depot	Tidal basin (Lae Urban)
5	Food processing industry development centre based on setting up of empty-can manufacturing company	Malahang industrial area (Ahi Rural)

Source: JICA Project Team

Metal working industry development centre

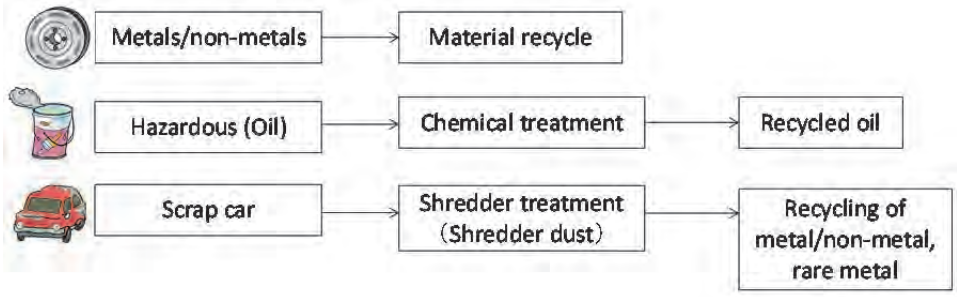
Metal working industry is projected to be installed in Kamukumung area. This industry aims to organize an industrial agglomeration related to the repairing of metalworking products such as automobile parts. It is expected that a lot of metalworking companies including small repair shops and service providers may enter into the area and operate their businesses.

Possible industrial wastes are metals/non-metals, plastics, rubbers (tyres), lubricant oils and mixed wastes. As similar type of business is gathering there, generated wastes from each firm should be similar to some extent. Therefore, to increase recycling rate it is preferable to collect wastes comprehensively by recycling firms.

As of year 2016, there are recovery and recycling markets of metals/non-metals. Recycling technology of lubricant and fuel oils through chemical treatment exists in developed countries including Japan. Currently waste generators are directed to keep their hazardous wastes, e.g. used oil, in their estates. Therefore, such technology should be transferred to this area from environmental point of view as soon as possible. Local level governments should make efforts to attract private companies with the recycling technology to this area. The other wastes, i.e. plastics, rubbers (tyres) and mixed wastes, are dumped at the final disposal site at present. Those wastes can be recycled by high recycling technology as well.

Besides, automobiles (car, truck, bus, motorbike, etc.) will be fixed by using parts manufactured there. In the repairing process, some of them may be required to be scrapped. In such case, currently there is no scrap car treatment facility in PNG. Consequently, broken-down cars left in

vacant lands are seen here and there in Lae Urban Area. The number of scrap cars is expected to rapidly increase in future. Therefore, establishment of scrap car treatment facility should be planned in this area. Automobiles include huge amounts of valuables like metal/non-metal and rare metals like platinum. The treatment process requires equipment such as shredder (crusher) machine and crane. If the facility is developed, this area would become a model of scrap car recycling and positive contribution on environment is highly expected.



Source: JICA Project Team

Figure 12.8.13 Utilization of Metal/Non-metal, Oil and Scrap Car

Wood working industry development centre

In this Master Plan, manufacturing of wood products such as furniture, toys and other woodwork products, interior goods utilizing local wood resources are planned in Yalu industrial park. This industry generates huge amount of wood waste. Wood waste can be utilized in several purposes.

"Wood fuel" is generally used for cooking in rural areas.

"Sawdust" can be utilized as a material for moisture control in producing compost. In the master plan of waste management sector, composting of organic waste is one of the target items for 3Rs activities, thus the sawdust could be used in the composting production process.

"Wood chips" can be utilized for several kinds of purposes. For instance, wood chips are exported as biomass fuel for wood-burning power plants. Wood fuel is considered as a carbon neutral resource which does not emit carbon dioxide additionally. From view point of global warming, the number of power plant utilizing biomass fuel would increase all over the world. Thus the demand of wood chips may be increased as well (see below Topic). Other than that wood chips could be used as livestock bed, particle board materials, exterior materials, base course material at recreation trails, etc.

Topic

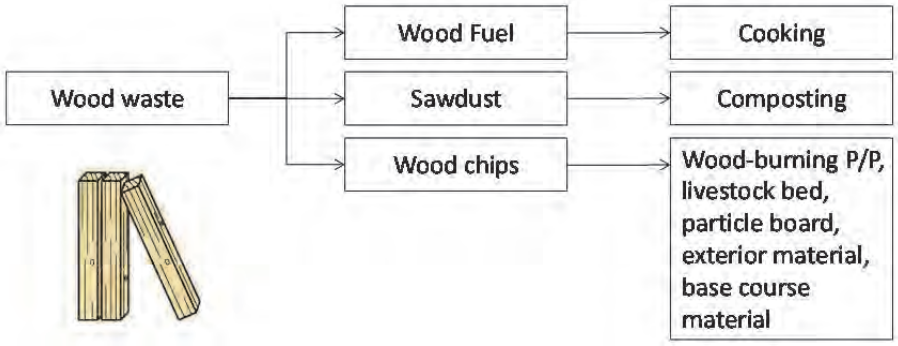
Markham Biomass will produce power from wood chips. PNG Power Ltd. (PPL) signed an agreement with Markham Biomass through Aligned Energy to buy renewable energy from tree sources to boost PPL's power supply. Young girls and children from Mayamzariang Village in Umi-Atzera local level government in Markham Valley, Morobe are planting young biomass trees (*Ecylyptus Pellita*), adding on to the 18 acres (7.2 hectares) in the background. Markham Biomass is responsible for organizing the plantation. Mayamzariang villagers are happy to offer their customary land to increase the bio-mass production.

Other than the new energy supply project by Markham Biomass, PPL made agreements with Oil Search Ltd. through New Guinea Petroleum Ltd. and Landfill Energies Ltd. for energy supply from burnt city wastes and fired gas energy respectively.

(Source: Renewable energy..., page 12, The National – Friday, February 26, 2016)

Among those options, wood chips may be the most value-added products in terms of business. It would be a good opportunity to develop local business producing high added-value wood chips

utilizing local materials in the area.



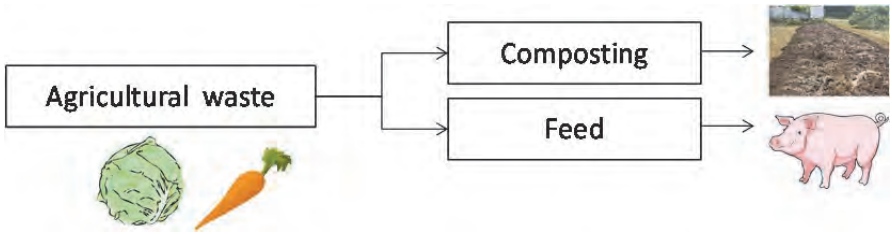
Source: JICA Project Team

Figure 12.8.14 Utilization of Wood Wastes

Agro products consolidating depot

This facility is a logistic centre for agricultural products, which would be located in Tidal basin. Huge amount of vegetable waste would be generated due to the facility. The agricultural waste can be utilized as material of compost. Other than that, the waste could be utilized as feed for livestock such as pig, which requires complete sanitary management to avoid animal pathogen from coming into the industrial area.

It is preferable that the wastes are collected and managed by the association of the facility collectively, and contractors transport them to livestock companies.



Source: JICA Project Team

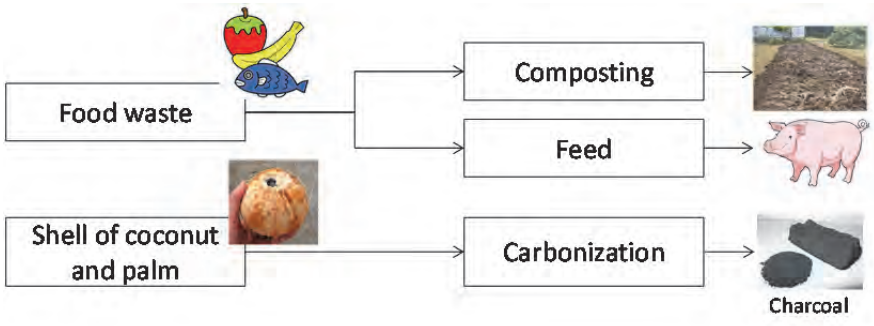
Figure 12.8.15 Utilization of Agricultural Wastes

Food processing industry development centre

This facility is a food processing agglomeration centre, where a lot of small-sized food processing firms would operate their factories and have their final products canned within the centre. Different from above “Agro products consolidating depot”, huge amount of food wastes may be generated in the process of food materials.

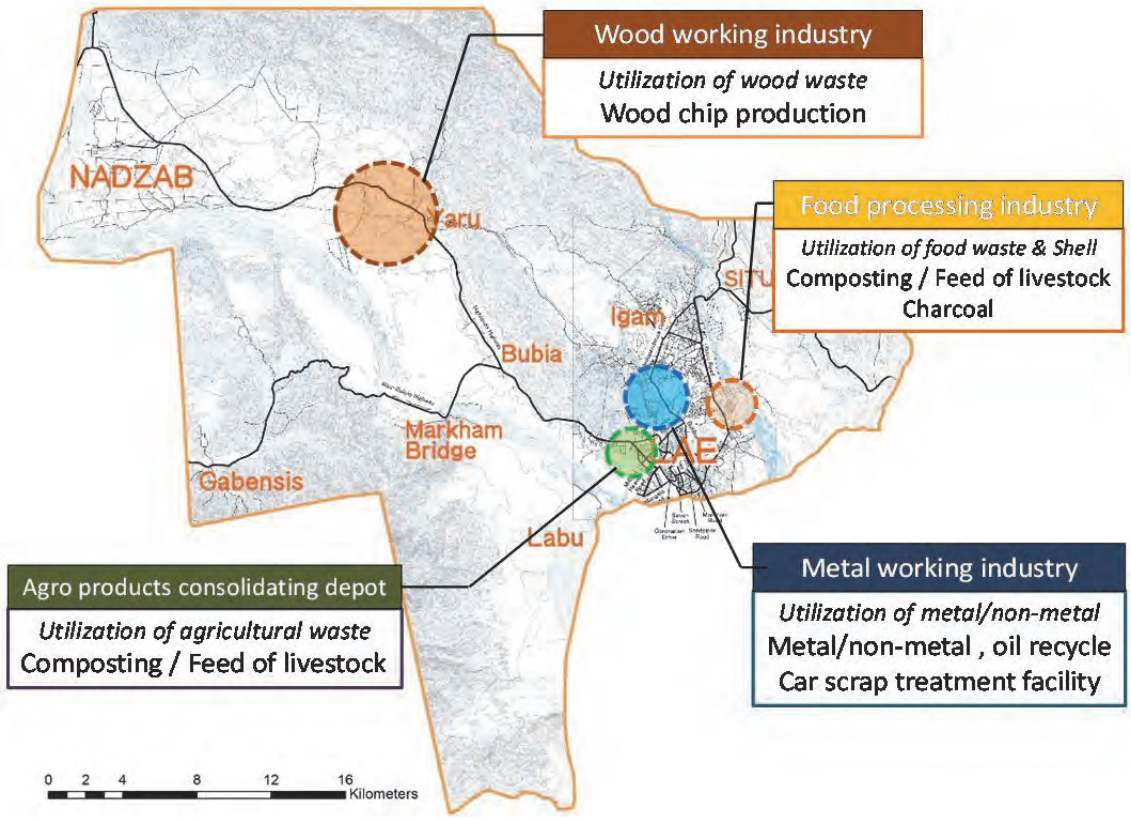
Food waste such as agricultural waste, meat and fishes can be composted. Other than composting, some of the food wastes can be applied to livestock feed.

On the other hand, hard shells of coconut and palm are difficult to be biodegraded due to its fiber. The shells are usually disposed of at dumpsite or vacant lands. In some developed countries, carbonization technology is developed. Carbonization process requires a temperature of 280 ºC above to convert such shells into charcoal. The produced charcoal could be utilized as a biomass fuel instead of fossil fuels. As there are a lot of plantation of coconut and palm in the Project Area, huge amount of shell is generated regularly. Therefore, if local level governments attract private companies having interest in the business, it would be a good opportunity to develop a new recycling industry in the Project Area.



Source: JICA Project Team

Figure 12.8.16 Utilization of Food Wastes



Source: JICA Project Team

Figure 12.8.17 Map of Material Utilization

c) Hazardous Waste Treatment

Hazardous wastes are generated from medical facilities and industrial sector. Appropriate treatment of the wastes is very important in terms of environment and health.

Medical Facility

Infectious wastes such as syringes, needles and cytotoxic wastes generated from medical facilities are supposed to be incinerated. Currently Angau Memorial General Hospital is the only facility owning and operating an incinerator in the Project Area. Actually most of small-sized medical facilities are not able to haul their infectious wastes to Angau Hospital due to budgetary limitation. In order to handle those infectious wastes, local level government should provide route collection services in lower price.

As shown in Table 12.8.15, the generation amount of infectious wastes in the Project Area is estimated to be 251 ton/year (1.0 ton/day) in year 2017, 311 ton/year (1.2 ton/day) in year 2025 and 605 ton/year (2.3 ton/day) in year 2050. Current treatment capacity of the existing incinerator

(batch type) is 70 – 100 kg/hour. Considering working hours of Angau Hospital and operation rate of the incinerator, daily treatment capacity is estimated to be 0.5 – 0.7 ton/day. Therefore, new incineration plant with larger capacity should be installed as soon as possible. As for the location, the incinerator should be installed outside the hospital taking into consideration the adverse impacts on air and health of patients and medical staffs.

On the other hand, the installation and operation of the incineration plant could be implemented by private firm after the site and incineration type are approved by health inspector of local level government. The incineration fee for the medical wastes is generally higher than that for municipal solid wastes. Thus if the collection system is established in the Project Area, it is expected that private firm(s) would invest on this business.

Industrial Sector

The hazardous wastes generated from industrial sector should be strictly managed under the Polluter Pay Principle (PPP). Currently local level governments do not treat the hazardous wastes. There is no intermediate treatment facility for the wastes in the Project Area, thus waste generators are not able to have those wastes treated appropriately and cannot help storing them within their properties. This is one of the critical issues on waste management in the Project Area. Since Lae Uban area is the most industrialized area in PNG, the amount of hazardous wastes is expected to rapidly increase according to the industry development. As suggested in the section of "metal working industry development centre" (Section 12.8.2.5), recycling firms for used oil are highly expected to enter into this area and operate their business. In addition, the other hazardous wastes such as strong acid/alkali liquid and PCB (polychlorinated biphenyl) -contaminated wastes must be strictly managed and properly treated. Since these hazardous wastes are difficult to treat, advanced recycling technology is required. Thus, technical transfer should be considered from developed countries including Japan.

3) Rehabilitation of Existing Dumpsite and Construction of Sanitary Landfills

a) Infrastructure

To establish sanitary landfills in the Project Area is indispensable from environmental and social point of view. Even if the other policies are completed, the waste management system will not function unless the final disposal sites are developed in sanitary manners.

The sanitary landfill can avoid the following adverse impacts;

- Air pollution by smoke emitted from waste combustion at dump site
- Surface water pollution by leachate from dumped waste
- Methane emissions by anaerobic fermentation of organic wastes
- Generation of odour and bugs
- Terrible conditions for waste pickers and their health problems

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

Proposed facility is presented in Table 12.8.21.

Table 12.8.21 Proposed Landfill Facility

Category	Name of facility	Description
Landfill	Lining system	Water-proof liner, e.g. diorite and clay (Baruni Landfill), is installed. Material shall be determined from geological and financial point of view.
	Pipeline for air and leachate	Air comes from downstream of pipeline and leachate is collected through this equipment.
	Gas exhaust pipe	Gas from landfill is distributed through this equipment.
Leachate treatment	Leachate pond	Leachate from landfill, which is treated to meet waste water quality standards (WHO Guidelines, wastewater quality standard)

Category	Name of facility	Description
		before discharge to outside.
Monitoring	Monitoring facility	Tube wells for ground water monitoring. Water quality monitoring at leachate pond.
Administration	Office	Office building for management works
	Parking	Parking for heavy machines
Others	Road	Hauling road, entrance road
	Entrance gate	Entrance gate is installed to control trucks coming during closing time.
	Fence	Around administration building and parking

Source: JICA Project Team

Considering the current land use condition of the existing dumpsite, roughly half of the estate could be used for the sanitary landfill with 2.5 hectares and leachate pond with 0.5 hectares. The size of the leachate pond must be recalculated according to the solid waste composition and precipitations in detail design phase.

On the other hand, remaining half of the land would be used as the open dumping site as it is today until the sanitary landfill is commissioned. However burning activity should be banned in accordance with the Public Nuisance Law (amended), 1998. When the sanitary landfill is closed, the open dumping site should be finalized by covering with soil and gas exhaust pipes should be installed appropriately.

b) Social Consideration to Waste Pickers

According to LULLG, 30 – 40 waste pickers segregate recyclables and make their living by selling them to recovery and recycling firms. Some of them are feeding pigs outside the dumpsite and selling them.

If the dumpsite is rehabilitated and make them get out from there, they will entirely lose their income sources. Then social conflict should occur and the stable operation of the facility may not be secured due to its security reason. Therefore appropriate consultations with waste pickers should be conducted adequately and consensus should be achieved on the development project between Lae District and waste pickers.

To solve this issue, Lae District should let them continue their waste-picking activity there under governmental control even after the rehabilitated landfill is commissioned. The segregation of valuables from wastes contributes to reduction of waste amount at dumpsite and consequently the lifetime of the new landfill would be extended.

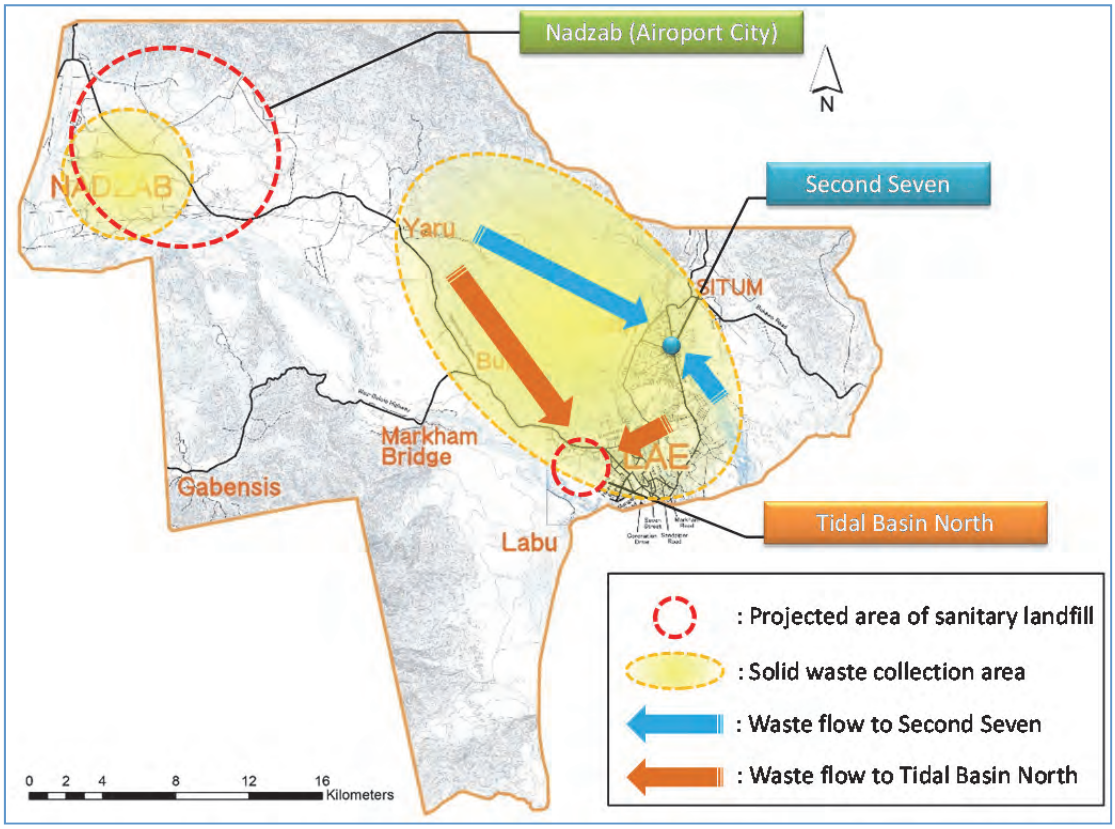
According to simulation as shown in Figure 12.8.11, Second Seven Landfill is anticipated to be closed in year 2028 due to its capacity limitation. The landfill site would be covered with soil and should be managed continuously by Lae District. It means that waste pickers would lose their main income sources. Local level government should address this issue by implementing the social augmentation program. For instance, training and capacity building activities are provided for enhancing their earnings and living standards. Training programs may be preferable to focus on local industries with low skills such as agriculture, livestock industry, etc.

c) Additional Construction of Sanitary Landfills

As described in Section 12.8.4, additional landfills should be constructed for retaining solid waste after 2025. Although the collection areas should be discussed in accordance with collection capacity and the conditions of population increase in the future, the Second Seven Landfill and additional landfills prepared in Lae Urban Area would cover northwest area including Yalu area as shown in Figure 12.8.18. The required land will be 16 ha at northern area of Tidal basin. The candidate site is located at left bank of Markham River. Since there are vast wetlands there, environmental consideration should be made in preparation of environmental impact assessment report. Besides, geological characteristic, e.g. groundwater aquifer, should be investigated in preliminary survey.

Regarding the airport city development, the location is so far from Lae Urban Area that solid wastes generated there could not be transported to Lae Urban Area. Therefore, separate sanitary landfill should be prepared. The required area would be 1.5 hectares. Since the development is planned to be completed in 2025, the land should be selected and acquired from landowner(s). This sanitary landfill project should be spatially described in the urban planning.

The situation of final disposal sites by year 2050 is shown in Table 12.8.22.



Source: JICA Project Team

Figure 12.8.18 Image of Waste Collection Area and Waste Flow

Table 12.8.22 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 hectares)	North of Tidal basin (Cell-I) (5 hectares)	North of Tidal basin (Cell-II) (5 hectares)	North of Tidal basin (Cell-III) (5 hectares)
Period	2016-2024		2025-2045		2046-2050
Nadzab Airport Area					
Sanitary landfill	-		Nadzab Airport City (Cell-I) (0.5 hectares)		Nadzab Airport City (Cell-II) (0.5 hectares)

Note: * Waste pickers segregate recyclables
Source: JICA Project Team

d) Land Use after Closure of Landfills

Each sanitary landfill will be closed after being fulfilled with wastes. Since the ground after closure of landfill sites is unstable, the land use of the closed landfill is limited. Generally those lands after closure are used as park, golf course, play ground, recreation area, public facility area, etc. For land use of the land, the ground condition should be assessed in designing phase. The

land use after closure should be considered in urban planning.

e) Fair Allocation of Required Budget

Even if sanitary landfills are constructed in sanitary manner, the operation and maintenance would not conducted appropriately and sustainably unless financial assistance is fairly allocated to local level governments from national government. Financial assistance is required for operation and maintenance fees of landfill site, vehicles (inspection cars) and its fuel cost, employment cost, etc.

4) Cooperation with Stakeholders on Reduce Action of Organic Waste

Organic wastes are generated from houses, business activities, markets and projected industry development centres as well. Composition rate of the organic wastes is estimated to be 30 – 40% of all wastes generated from the Project Area. Reduction of organic waste amount contributes to the extension of lifetime of dumpsite and the improvement of environment, e.g. air and groundwater quality, and mitigation of bug generation.

There are nine illegal dumpsites at mini markets in the Project Area, where huge amount of organic waste are dumped without any treatment. The disposed organic waste should be treated appropriately as soon as possible. In Lae District, Lae Main Market in Lae Urban Area is the only market provided with waste collection service by local level government.

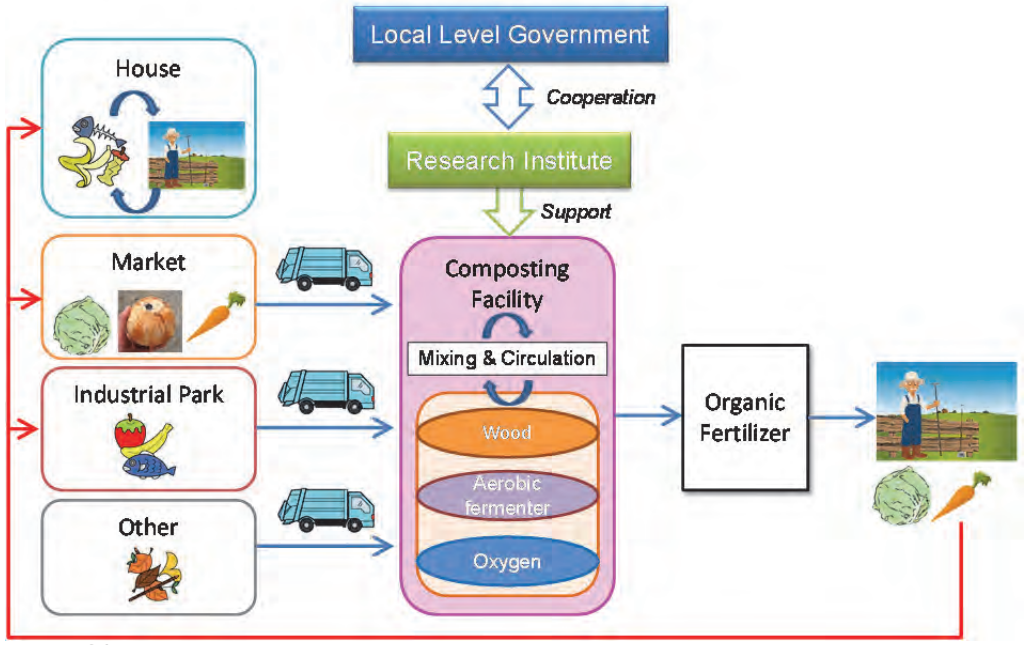
From projected industry development centres of food processing and agro products consolidating depot, certain amount of organic waste would be generated. Those organic wastes have to be treated as well.

Treatment methods of organic wastes generated from each generator are suggested by evaluating some criteria such as the type of wastes, generation amount, easiness of waste collection and stability of waste generation. The result is shown in Table 12.8.23. As a result, households are recommended to conduct the composting at their houses and utilize it to their farms or gardens. The other generators are expected to do composting at a consolidated composting facility.

Table 12.8.23 Treatment Method of Organic Waste from each Generator

Generator	Type of organic waste	Amount	Waste collection	Stability of waste generation	Proposed Treatment
Household	Wide variety	Small	Inefficient	Not stable	Private composting
Market	Limited (vegetable, fruit)	Large	Efficient	Stable	Composting facility
Industry development centre	Medium (vegetable, meat, fish, etc.)	Large	Efficient	Stable	Composting facility
Other	Medium (grass, pruned tree, etc.)	Medium	Medium	Medium	Composting facility

Source: JICA Project Team



Source: JICA Project Team

Figure 12.8.19 Image of Organic Waste Recycling Loop

The pilot project of composting organic waste should be conducted in order to find out the best way to produce high quality compost with low cost. On the other hand, the composting process requires thorough control of moisture, temperature and oxygen for producing quality product. In order to accumulate scientific data of composting, the Project should be conducted in association with local research institute, e.g. NARI, and agricultural department of school, e.g. Malahang Technical High School as shown in Figure 12.8.19. If necessary, technical transfer may be considered from international cooperation agency with adequate experience in similar projects such as JICA. The duration of the pilot project is about two years.

The location of the pilot project facility should be discussed between research institute, high school and local government. If food wastes such as meats and fishes are composted, the fermentation process emits odour and sometimes conflicts are raised from people living near the facility. Taking into consideration this social risk as well as budgetary limitations, it is preferable to utilize the land owned by the research institute or school. The required land may be at most 1 ha where a building with wall and roof is constructed for avoiding organic materials and products from rain fall. Waste generators such as markets are expected to cooperate in provision of their wastes regularly to the pilot project.

The produced organic fertilizer should be tested at actual farms. Local farmers are expected to be involved in the test and give their feedback comments to relevant organizations for further improvement. This cycle among those stakeholders should be repeated several times. The basic data and composting method obtained in the pilot project should be disclosed widely via website and public offices so that private firms get to know the composting method in detail and have interest in the business.

After the pilot project, first of all the actual implementation should be started for domestic waste. Citizens should be provided with booklets by which they learn the importance of organic waste reduction and how they can make compost at their houses.

The composting business should be operated by private firms in future. The point of operating the business is how to collect adequate amount of organic waste and to gain stable clients purchasing the organic fertilizer. Since compost is nutrient-rich, it has high value in fertilizer market. However if the product is not sold, the business cannot be sustainable. As one of the assistance measures, for instance, the agricultural cooperatives/unions established in each industry development project would purchase the fertilizer and resell them to their clients till their business becomes stable.

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

a) Improvement of Divisions Responsible for Waste Management

Current administrative conditions of local level governments concerning waste management are shown in Table 12.8.24. Only LULLG has regular officers responsible for waste management. As to the other local level governments, health inspectors or environmental health officers are supervising the waste management along with the other roles for health and public sanitation. To achieve the sector vision, more officers should be allocated to the waste management, who undertake broad-area waste collection and transportation service, 3Rs activities, organic waste pilot project, development of by-laws, policies and regulations, rehabilitation of the existing dumpsite, and construction of new landfills.

In short-term development till year 2025, the expansion of administrative jurisdiction of LULLG is proposed in order to manage and implement the items proposed in this sectoral master plan.

Table 12.8.24 Responsible Officer of Waste Management

District	LLG	Responsible officer for waste management
Lae	Lae Urban	Health inspector (Waste Management Div. of Health & Community Services Dept.)
	Ahi Rural	District environmental health officer
Huon Gulf	Wampar Rural	Provincial health inspector
Nawaeb	Nabak Rural	District health inspector
	Labuta Rural	District health inspector

Source: Morobe Province, Lae District, LULLG

b) Waste Collection Vehicle

As described in Section 6.8.2, (2), LULLG is the only local level government providing with collection and transportation services. Currently 17 trucks in total are used for the service. LULLG has two dump trucks with two cubic metres loading capacity each, and the operation of remaining 15 trucks with same loading capacity is entrusted to local contractors. Although LULLG had 32 compactor trucks in the past, all of them were broken down. Since there is no car repair factory in the Project Area, the compaction trucks could not be fixed.

Taking into account the budgetary constraints, owning such trucks is not recommended. The collection and transportation services should be continuously outsourced to contractors for appropriate price. Table 12.8.25 shows the estimated number of required trucks for collecting municipal solid waste in the Project Area. The number might be decreased according to the capacity development effects on the collection and transportation services.

Table 12.8.25 Number of Required Trucks

Year	2017	2025	2035	2045	2050
Number of required truck	17	29	52	96	131

Source: JICA Project Team

c) Waste Collection Capacity Development

Appropriate collection and transportation of solid waste lead to the increase of collection points and cover area would be widened currently. Collection points are allocated by zones and each contractor is implementing their services. The collection efficiency depends on their capacity.

Local level government does not provide any training for improvement of their skills so that present collection system is not efficient.

Firstly, the current conditions of the services should be analysed by implementing “Time and Motion Study”. The purpose of the Study is as follows;

- To establish the waste management data base,
- To determine the volume of wastes collected within certain period and the number and type of premises provided with the service, and

- To disseminate realistic and up-date public information on daily waste collection.

Since this Study requires specific skills and experience, technical assistance should be provided from international cooperation agency such as JICA or local government such as NCDC. JICA has already conducted this Study with NCDC in Port Moresby before.

Other than the efficiency, attention should be paid to safety measures during their collection works as well. Contractors are provided with groves from LULLG to avoid injury when they pick up dangerous wastes such as broken glass, sharps, needles, and so on. However most of contractors do not wear the groves.

d) Solid Waste Composition Analysis

No solid waste analysis has been implemented in the Project Area. It is indispensable for waste management administration to understand the current situation of solid waste composition and solid waste amount transported to final disposal site. The waste composition analysis should be supported by experienced team. NCDC has the experience at Baruni Dumpsite in association with JICA, thus their cooperation may be supportive. This analysis should be conducted as soon as possible.

e) Improvement of Operation of Final Disposal Site

No proper management is conducted at Second Seven Dumpsite. This sectoral master plan proposes the rehabilitation of the dumpsite till year 2020. Current negative impacts such as air pollution, odour and bugs generation could be mitigated considerably through the upgrade. On the other hand, the management capacity is a different matter. Even if the current dumpsite is changed in a sanitary manner, the environment would return to initial conditions unless proper management is implemented there. Therefore, technical assistance should be provided to government officers, who are actually working at the dumpsite, from international cooperation agencies such as JICA.

f) Inspection of Illegal Dumping

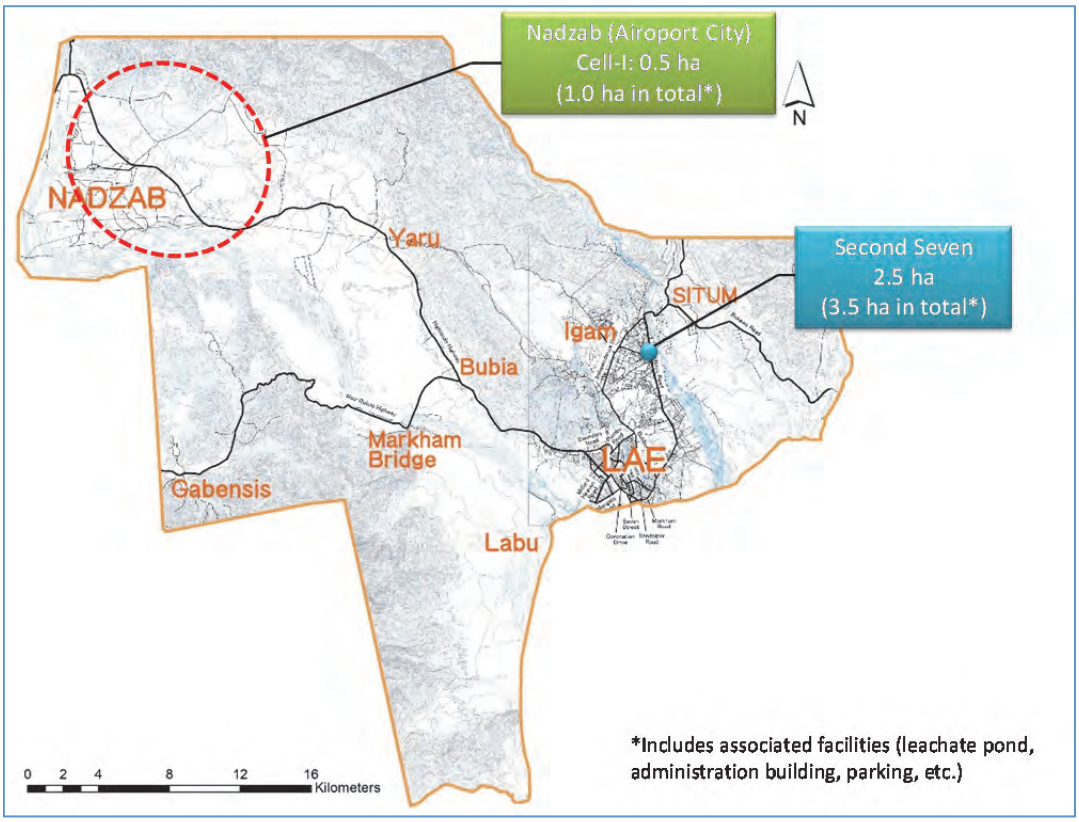
Illegal dumping is found in mini-markets, settlement areas, public places, road sides, etc. According to people's convention, they usually throw wastes into drains and rivers especially in rural areas.

Food wastes generated from mini-markets are accumulated in the backyards of each market without any control. If the current situation is continued, the wastes would overflow. Composting is the first step toward solution. The waste reduction activity should be tackled as soon as possible.

Regarding the other illegal dumping, local level governments should inspect them by regular patrol. In addition, a reporting network system should be established in cooperation with police and citizens.

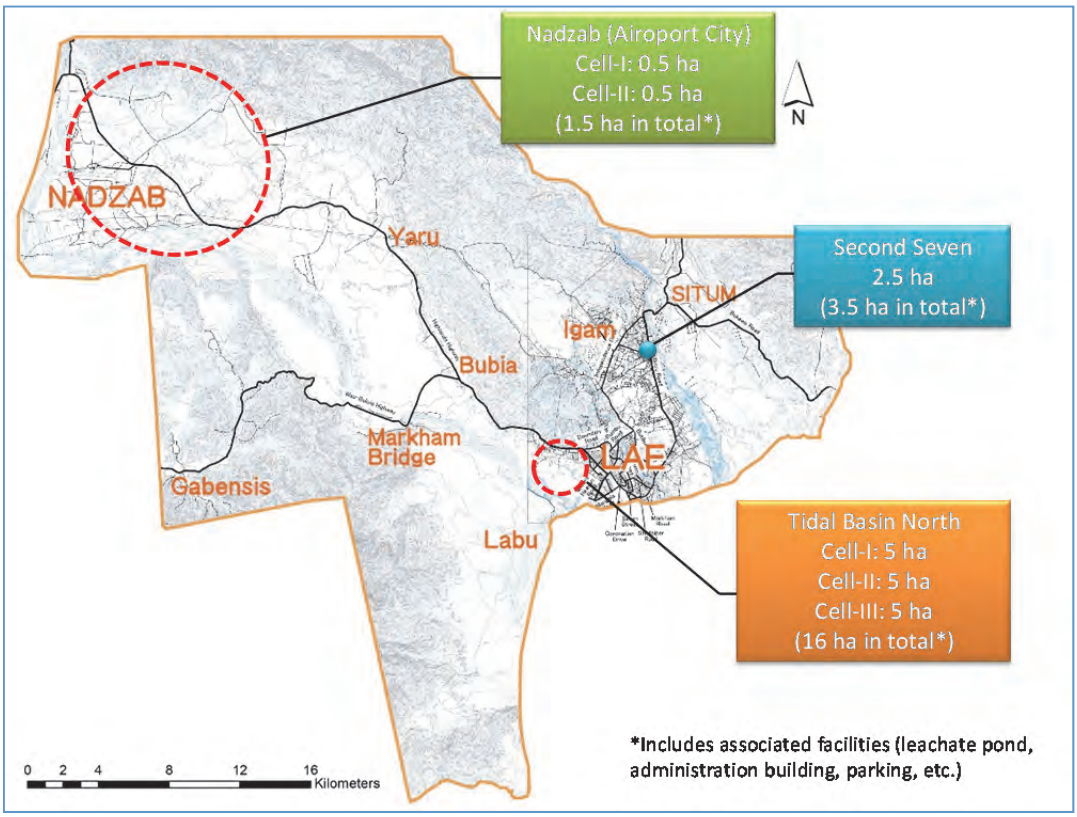
(2) Candidate Site of Landfills

The candidate sites of sanitary landfills are presented in Figure 12.8.20 and Figure 12.8.21. Proposed intermediate facilities in each industrial development centre area are not included in following figures because these facilities are expected to be launched by private firms in principle.



Source: JICA Project Team

Figure 12.8.20 Map of Landfill Candidate Sites (2017-2025)



Source: JICA Project Team

Figure 12.8.21 Map of Landfill Candidate Sites (2026-2050)

(3) Solid Waste Management Project

Proposed solid waste management projects are summarized below.

No	Project Title	Project Outline	Proposed Location
WM-1	Second Seven Dumpsite Rehabilitation Project	Second Seven Dumpsite is an open dumping site located in Lae Urban Area. As the dumpsite has adverse impacts on environment and health of people, it should be rehabilitated in environment -friendly manner with semi-aerobic sanitary landfill system (Fukuoka Method). The lifetime of the rehabilitated Second Seven Landfill with 2.5 hectares (landfill area) is estimated to be about 9 years. Considering the associated facilities such as leachate pond, administration building and parking for heavy machines, another 1 ha is necessary. In total 3.5 hectares should be ensured at the site.	Second Seven Site, Lae City
WM-2-1	Tidal Basin North Landfill Construction Project [Cell-I]	After rehabilitated Second Seven Landfill is fulfilled up to its capacity, transport direction of solid waste would be shifted to the new sanitary landfill site constructed. As the candidate site for the facility, hinterland of Tidal Basin (Tidal Basin North) with 15 hectares (landfill area) is projected. As the associated facilities require roughly 1 ha, land with 16 ha in total should be ensured at the site. For the first period (2029 – 2039), the Cell-I with 5 hectares landfill area is to be used.	Tidal Basin West End at Markham River Bank
WM-2-2	Tidal Basin North Landfill Construction Project [Cell-II]	For the second period (2040 -2046), the Cell-II with 5 hectares landfill area is to be used.	Tidal Basin West End at Markham River Bank
WM-2-3	Tidal Basin North Landfill Construction Project [Cell-III]	For the third period after 2027, the Cell-III with 5 hectares landfill area is to be used, which area can be used after 2050 due to its adequate capacity.	Tidal Basin West End at Markham River Bank
WM-3	Project for Capacity Development of Landfill Operation	Proper management should be implemented at Second Seven Dumpsite. Technical assistance should be provided to government officers, who are actually working at the dumpsite, from international cooperation agencies such as JICA.	Morobe Provincial Government, LULLG
WM-4-1	Nadzab (Airport City) Landfill Construction Project [Cell-I]	An airport city development is planned around existing Nadzab Airport till year 2025. Since this area is too far from Lae Urban Area to bring the wastes generated in this area to Lae Urban Area, new sanitary landfill should be prepared separately for the airport city. Required land area is 1.5 hectares in total till 2050 at the site, which includes 0.5 hectares land for the associated facilities. Cell-I with 1.0 hectare landfill area is to be used till 2045.	Nadzab Area
WM-4-2	Nadzab (Airport City) Landfill Construction Project [Cell-II]	Since the Cell-I is anticipated to be fulfilled till 2045, Cell-II with 1.0 hectare landfill area should be developed additionally in the same location. This landfill site can be used after 2050 due to its adequate capacity.	Nadzab Area

(4) Implementation Schedule

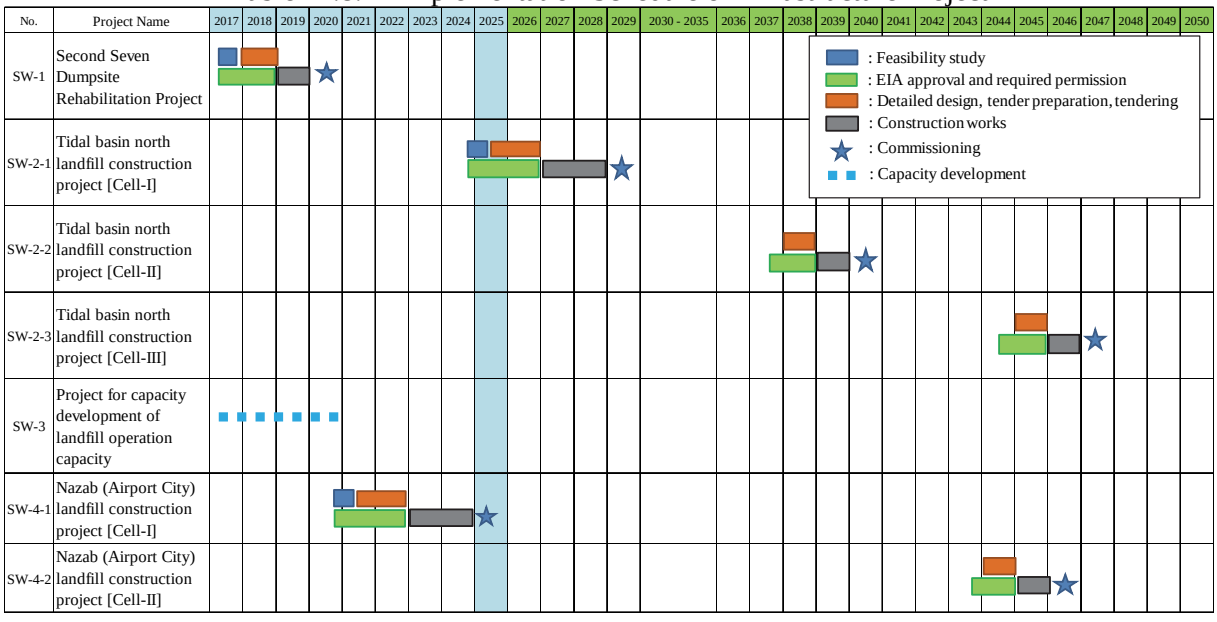
The basic principle of master plan for waste management is shown in Table 12.8.26. Implementation schedule of infrastructure project is illustrated in Table 12.8.27.

Table 12.8.26 Basic Principle of Master Plan for Waste Management

Period	Basic principle	Promotion of 3Rs activities	Rehabilitation of existing dumpsite and construction of sanitary landfills	Cooperation with stakeholders on reduce action of organic waste	Capacity development for waste management sector of LLG	Establishment of associated laws, policies an regulations
2017 -2025	- Promotion of 3Rs activities - Development of recovery and recycling market - Upgrade of dumpsite - Construction of sanitary landfill - Renovation of waste management administration - Setting by-law, policy and regulation	- Dissemination activity by local governments - 3Rs activities by households and private sectors - New challenge: used oil recycling facility, scrap car treatment facility, wood chip production facility, compost facility	- Rehabilitation of Second Seven Dumpsite - Construction of sanitary landfill for Nadzab Airport City (cell-I) - Financial assistance from government is ensured for sustainable implementation.	- Compost pilot project - Implementation of compost activity (domestic)	- Solid waste composition analysis - Time and motion study - Increase of waste management officers - Improvement of landfill operation - Enforcement of illegal dumping inspection - Provision of medical waste collection service	- Preparation and execution of broad-based by-laws - Preparation and execution of policies and regulations
2026 -2050	- Further promotion of 3Rs activities - Proper management of landfills	- New challenge: carbonization facility	- Closure of Second Seven Dumpsite - Construction of sanitary landfill at Tidal basin north (cell-1, II & III) and for Nadzab Airport City (cell-II)	- Establishment of compost facility (private firm)	- Further capacity development	- Preparation and execution of laws by type of materials

Source: JICA Project Team

Table 12.8.27 Implementation Schedule of Infrastructure Project



Source: JICA Project Team

12.9 Disaster Management & Storm Water Drainage

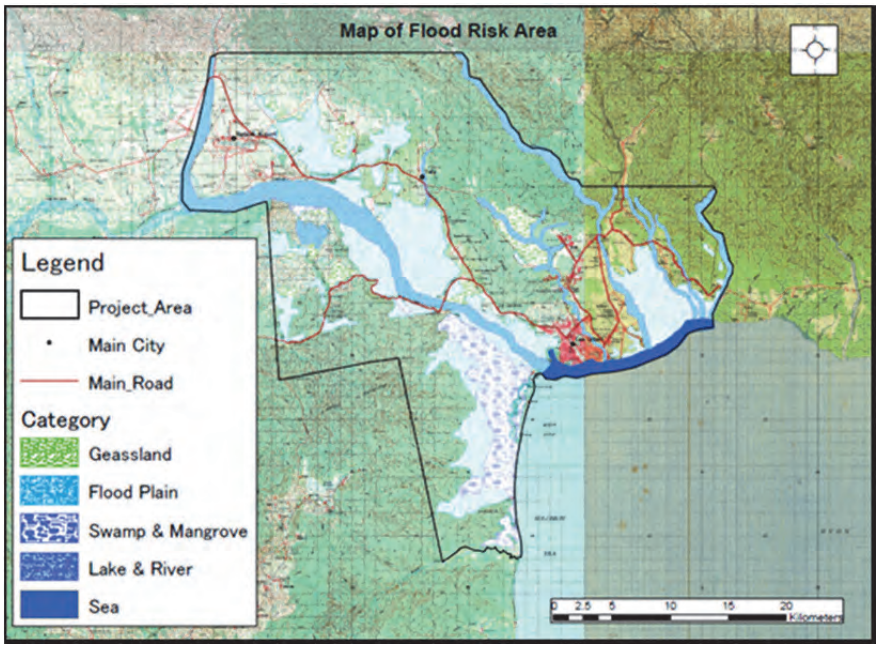
12.9.1 Disaster Management

As mentioned in section 6.9, 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 this problem.

Figure 12.9.1 shows the terrain characteristics of the Project Area. There is a high possibility of inundation of flood and storm surge in the low-lying area near to the river or the coast as shown in Figure 12.9.1. It is also required to take into account to this matter in this Study.

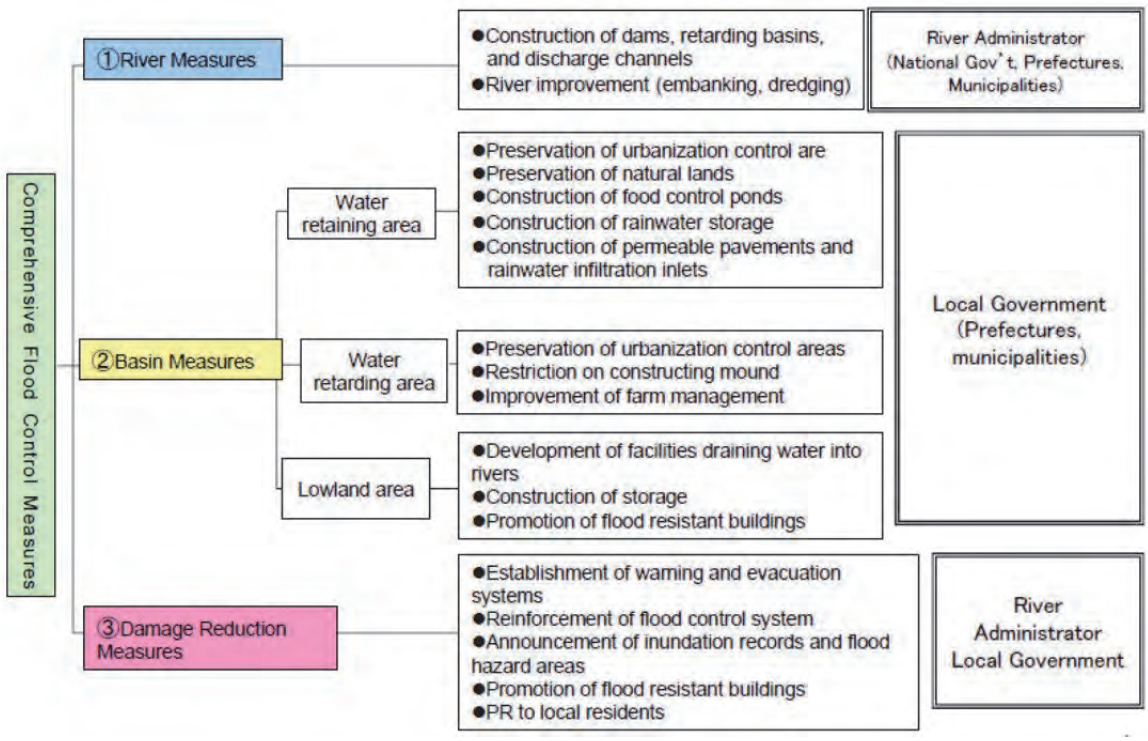
Levee construction and riverbed excavation require a very large amount of cost and time, therefore, it is difficult to achieve the goal in the short term. Moreover, along with the urbanization development, it becomes difficult to prevent flood damage in accordance with just one measure against flood, such as the levee. The comprehensive flood control measures shown below 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. Because rainfall data and water level data are the indispensable data for flood control plan, it is necessary to improve the hydrological observation network.



Source: JICA Project Team

Figure 12.9.1 Terrain Characteristics Map of the Project Area



Source: River Basin Management in Japan, Ministry of Land, Infrastructure, Transport and Tourism

Figure 12.9.2 Comprehensive Flood Control Measures

(1) River Measures

Source: Comprehensive Flood Control Measures in Japan, Ministry of Land, Infrastructure, Transport and Tourism

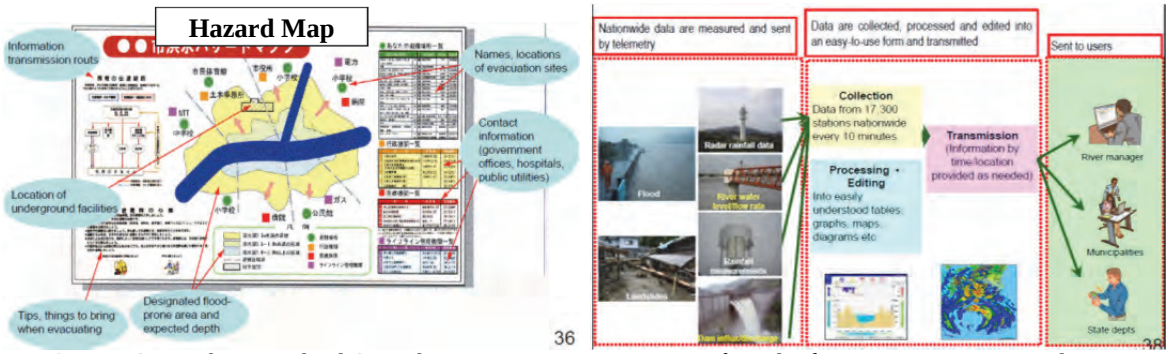
Figure 12.9.3 Examples of River Measures in Japan

(2) Basin Measures

Source: Comprehensive Flood Control Measures in Japan, Ministry of Land Infrastructure, Transport and Tourism

Figure 12.9.4 Examples of Basin Measures in Japan

(3) Damage Reduction Measures



Source: Comprehensive Flood Control Measures in Japan, Ministry of Land,Infrastructure, Transport and Tourism

Figure 12.9.5 Examples of Damage Reduction Measures in Japan

Photographs shown below are of ”the Sakaigawa Yusuiti Park”, the upper space of the Sakaigawa River Basin which was effectively used as a city park, and it is the first prefectural city park developed the river and the park cooperation.

Source: Provided by River Department of Yachiyo Engineering Co., Ltd.

Figure 12.9.6 Photos of Sakaigawa Yusuiti Park in Kanagawa Prefecture, Japan

12.9.2 Disaster Management & Storm Water Drainage Plan

12.9.2.1 Rainfall Intensity Duration Frequency (Rainfall IDF)

Only two meteorological stations under National Weather Service are located at Nadzab and Bubia in the Project Area. The rainfall depth is recorded from 10AM to 10AM of next day. The recorded data is transferred by every month to the Headquarter in POM. The rainfall gauging instrument is very old manual type. The short duration gauging is not recorded mechanically. The information and data for the rainfall intensity duration frequency (IDF) at the station in the Project Area is not available currently.

Observation Yard at BUBIA NARI

Rainfall intensity for the design storm is needed to calculate peak runoff rate from a drainage area for the design of storm water structures using the rational method. Time of concentration, return period, and an IDF relationship are used to calculate design rainfall intensity. As the rainfall IDF is not available in PNG, it is obtained as follows.

(1) Long-term (2 hours or more)

The rainfall IDF is calculated by using the Mononobe equation, which is very popular and used in Japan.

$r_t = R_{24}/24*(24/t)^{2/3}$

where; r_t : Rainfall intensity duration t
t : Duration of rainfall or time of flood concentration
R_{24} : 24-hour rainfall

(2) Short-term (less than 2 hours)

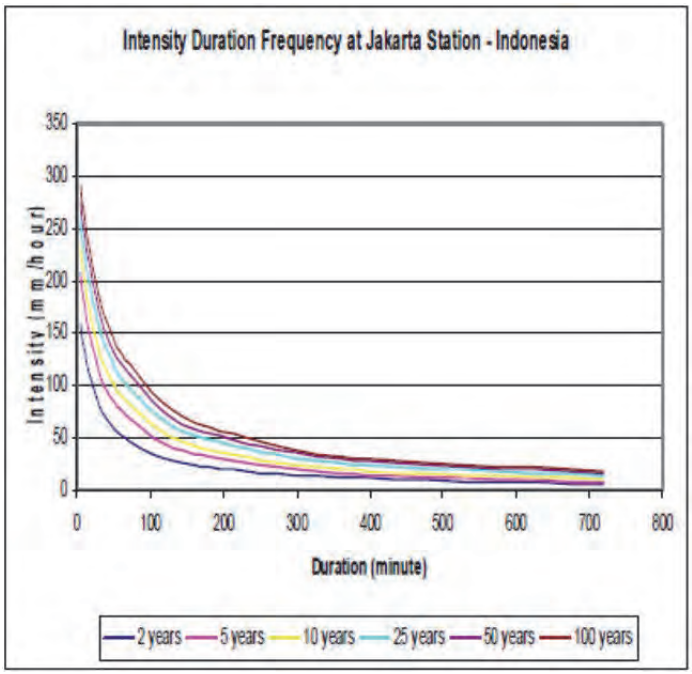
The rainfall IDF is available at Jakarta, Indonesia near PNG. As Jakarta is located in the vicinity of the equator as well as Lae City, here, the rainfall IDF at Jakarta (Meteorological and Geophysical Agency, Jakarta) is applied by adjusting an annual rainfall ratio.

Table 12.9.1 and Figure 12.9.7 show Depth Duration Frequency (DDF) and the rainfall IDF curve of Jakarta respectively.

Table 12.9.1 Depth Duration Frequency for Jakarta (unit: mm)

Year	2 min.	10 min.	15 min.	30 min.	45 min.	60 min.	120 min.
2	12.5	20.6	26.2	39.2	44.2	53.5	62.9
5	18.0	28.7	37.0	54.7	63.8	75.7	90.2
10	21.6	34.1	44.1	65.0	76.8	90.3	108.3
20	25.1	39.3	50.9	74.8	89.3	104.4	125.7
50	29.6	46.0	59.8	87.6	105.4	122.5	148.2

Source: Asian Pacific Friend Rainfall Intensity Duration Frequency (IDF) Analysis for the Asian Pacific Region, November 2008



Source: Asian Pacific Friend Rainfall Intensity Duration Frequency (IDF) Analysis for the Asian Pacific Region, November 2008

Figure 12.9.7 IDF for JAKARTA

The rainfall IDF for Nadzab and Bubia are estimated based on the value of Jakarta by multiplying the annual rainfall ratio shown in Table 12.9.2. The DDF for Nazab and Bubia are shown in Table 12.9.3 and Table 12.9.4 respectively.

Table 12.9.2 Average Annual Rainfall for Jakarta, Nadzab and Bubia

Station	Average annual rainfall (mm)	Observation period
Jakarta	2,067.0	1984 - 2009
Nadzab	1,481.9	1990 - 2010
Bubia	2,718.4	1990 – 2007 (missing period : 1994 - 1995)

Source: JICA Project Team

Table 12.9.3 Depth Duration Frequency for Nadzab (unit: mm)

Year	2 min.	10 min.	15 min.	30 min.	45 min.	60 min.	120 min.
2	9.0	14.8	18.8	28.1	31.7	38.4	45.1
5	12.9	20.6	26.5	39.2	45.7	54.3	64.7
10	15.5	24.4	31.6	46.6	55.1	64.7	77.6
20	18.0	28.2	36.5	53.6	64.0	74.8	90.1
50	21.2	33.0	42.9	62.8	75.6	87.8	106.2

Source: JICA Project Team

Table 12.9.4 Depth Duration Frequency for Bubia (unit: mm)

Year	2 min.	10 min.	15 min.	30 min.	45 min.	60 min.	120 min.
2	16.4	27.1	34.5	51.6	58.1	70.4	82.7
5	23.7	37.7	48.7	71.9	83.9	99.6	118.6
10	28.4	44.8	58.0	85.5	101.0	118.8	142.4
20	33.0	51.7	66.9	98.4	117.4	137.3	165.3
50	38.9	60.5	78.6	115.2	138.6	161.1	194.9

Source: JICA Project Team

Probable rainfall analysis is conducted for the maximum daily rainfall per year at Nadzab Airport and Bubia Station. The basic data were provided by PNG National Weather Service. (See Table 12.9.5)

Table 12.9.5 Maximum Daily Rainfall

Year	NADZAB	BUBIA
1990	64.4	115.8
1991	64.2	97.8
1992	221.0	206.6
1993	56.4	159.8
1994	86.0	-
1995	94.4	-
1996	62.6	94.8
1997	57.6	84.4
1998	74.8	166.4
1999	37.8	75.0
2000	85.2	105.6
2001	71.2	155.8
2002	70.4	108.4
2003	76.4	214.0
2004	70.8	94.0
2005	101.2	239.2
2006	63.8	126.0
2007	65.8	105.4
2008	107.4	-
2009	90.0	-
2010	90.2	-

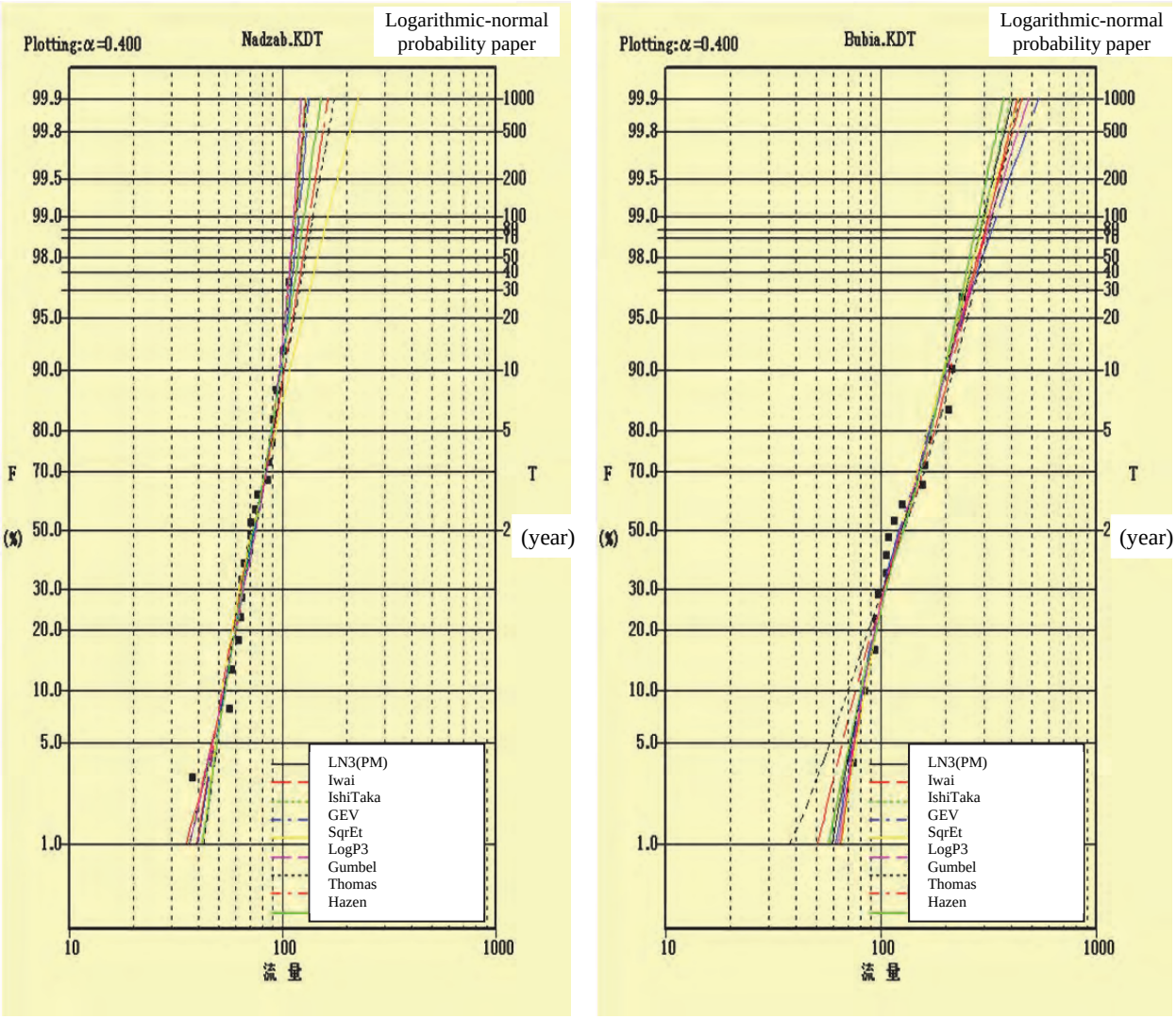
Source: NWS, PNG

As indicated, the average annual rainfall at Bubia is higher than that at Nadzab Airport. Generally, the rainfall in the coastal area is higher than in the inland. Based on provided rainfall data, the return period analysis is conducted by nine methods below, those methods are utilized well in Japan.

- Log-Normal Distribution 3 Parameter Moment Method (Slade II) ［**LN3 (PM)**］
- Iwai's Method ［**Iwai**］
- Ishihara's and Takase's Method ［**IshiTaka**)］
- Generalization Extreme Value Distribution ［**GEV**］
- SQRT-wxponential Type Maximum Distribution［**SqrEt**］
- Log Pearson Type III Log Probability (method of log number)［**LogP3**］
- Gumbel Distribution［**Gumbel**］
- Thomas Distribution ［**Thomas**］
- Hazen Distribution ［**Hazen**］

The results of the calculation is as shown in Figure12.9.8 and of the nine methods, GEV for Nadzab and Iwai for Bubia are selected due to satisfaction of the condition, that the SLSC (Standard Least Square Criterion) should be 0.04 or less. (See Table 12.9.6)

Probable Daily Rainfall for Nadzab and Bubia is shown in Table 12.9.7.



Source: JICA Project Team

Figure 12.9.8 Plotting Position for NADZAB and BUBIA

Table 12.9.6 SLSC for the Methods

	LN3 (PM)	Iwai	IshiTaka	GEV	SqrEt	LogP3	Gumbel	Thomas	Hazen
Nadzab	0.0374	0.0372	0.0374	***0.0299***	0.0638	0.0458	0.0465	0.0507	0.0538
Bubia	0.0439	***0.0396***	0.0449	0.0411	0.0501	0.0410	0.0439	0.0470	0.0493

Source: JICA Project Team

Table 12.9.7 Probable Daily Rainfall for NADZAB and BUBIA

Station	2 Yr	5 Yr	10 Yr	20 Yr	30 Yr	50 Yr	70 Yr	100 Yr
Nadzab	73.3	88.9	97.6	105.0	108.8	113.2	115.9	118.6
Bubia	123.2	168.4	201.0	233.9	253.6	279.1	296.3	314.9

Source: JICA Project Team

As shown in Table 12.9.7, the values at Bubia Station are from 1.7 to 2.7 times of the values at Nadzab. The probable values at Nadzab or Bubia Station shall be in consideration of the river's catchment for the flood runoff calculation.

12.9.2.2 Storm Water Drainage Management Plan

As previously mentioned in Chapter 6, the storm water drainage system are developed in large cities such as Lae City. Figure 12.9.9 shows a photograph of existing drainage and the typical dimension of drainage utilized in Department of Works.

The procedure of the storm water drainage system planning in the Project Area is shown below.

(1) Calculation Conditions

i) A 10-year probable rainfall estimated in paragraph 12.9.2 is adopted for the calculation of the discharge of drainages in the development zones (see Figure 12.9.8).

- 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) Dimensions of the drainage are given in Figure 12.9.13 based on the typical drainage as shown in Figure 12.9.11.

iii) Assume a drainage per 5 hectare Development Area as shown in Figure 12.9.12 .

iv) Rational Equation shown below is used for the calculation of discharge of drainage.

$Q = 1/360 \times C \times I \times A$

where ; Q : Maximum Design Discharge (m3/s)
C : Discharge Coefficient (See Table 12.9.8)
I : Rainfall Intensity duration concentration time (I shall be estimated by Table 12.9.3 and Table 12.9.4)
A : Drainage Area (ha)

Table 12.9.8 Discharge Coefficient

Region	Inlet time	
Region with high population density	5 min.	Trunk line: 5 min.
Region with low population density	10 min.	Branch line: 7 to 10 mi.
Average	7 min.	

Source: Sewerage Facilities Planning and Design Guidelines and Commentary, Japan Sewage Association

The flood concentration time is the sum of the inlet time and the flow time in principle. The inlet time is shown in Table 12.9.9 and the flow time is calculated by the equation 12.9.1.

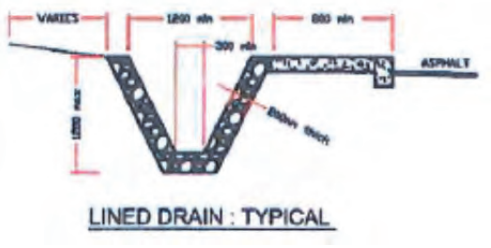
$t_f = Li / Vi$ … Eq. 12.9.1

where; t_f : Flow time (min.)
Li : Drain length (m)
Vi : Design velocity (m/s)

Table 12.9.9 Inlet Time

Area	Flow time (min.)
Mountainous drainage basin	30 / 2 km^2
Particularly steep-sloped drainage basin	20 / 2 km^2
Sewerage development district	30 / 2 km^2

Source: Manual for River Works in Japan (Planning), Ministry of Land, Infrastructure, Transport and Tourism



Source: Department of Works

Figure 12.9.9 A Photograph of Existing Drainage and Typical Dimension of Drainage

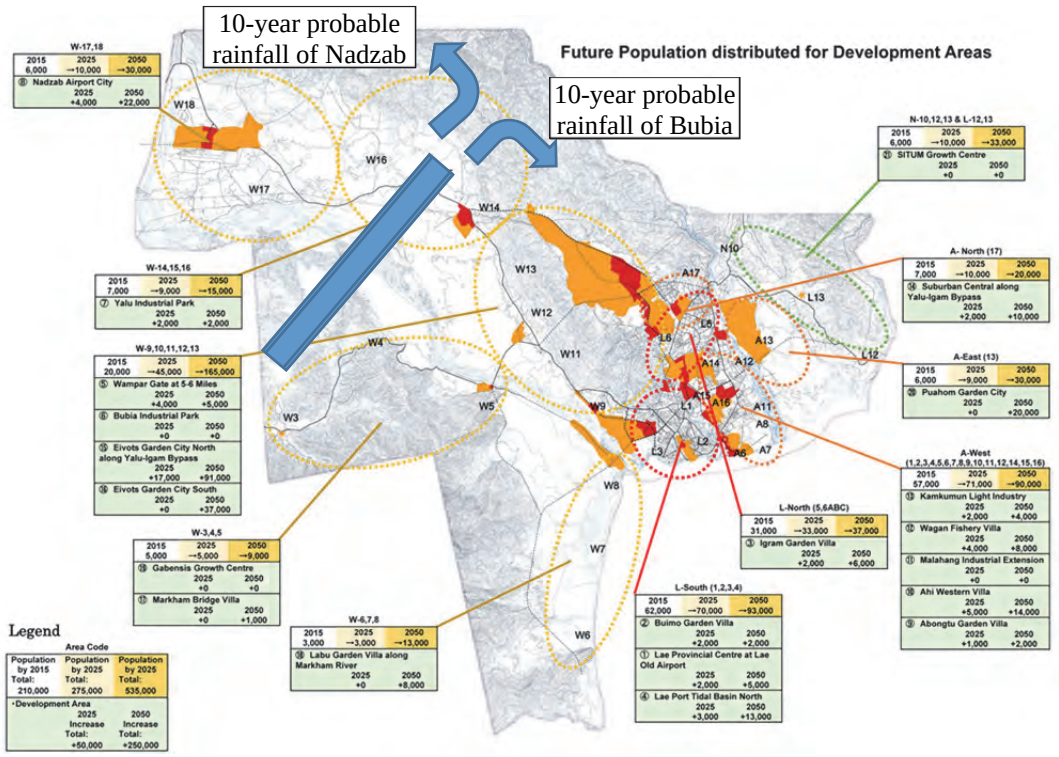
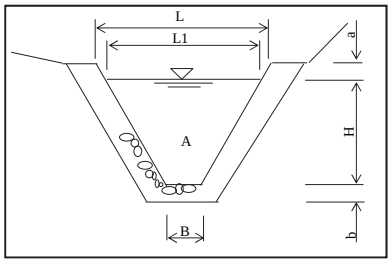


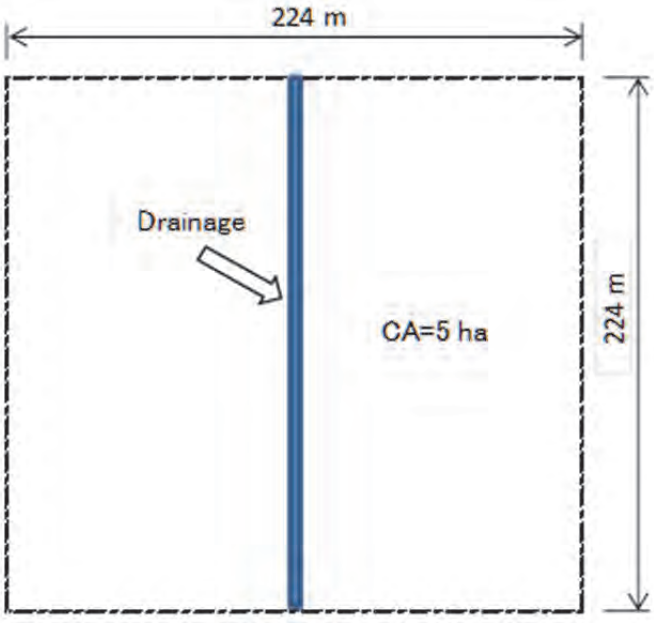
Figure 12.9.10 Development Zoning for Discharge Drainage

	n	I	L1(m)	L(m)	B(m)	H(m)	a(m)	b(m)	s	R	A(m^2)	V(m/s)	Q(m^3/s)
1			1.2	1.5	0.3	0.9	0.23		2.31	0.292	0.68	1.76	1.19
2			1.2	1.5	0.3	1.0	0.25		2.49	0.301	0.75	1.80	1.35
3			1.3	1.6	0.3				2.54	0.315	0.80	1.85	1.48
4			1.4	1.8	0.3	1.1	0.28		2.76	0.339	0.94	1.94	1.82
5			1.5	1.9	0.3				2.81	0.353	0.99	2.00	1.98
6	0.025	0.010	1.5	1.9	0.3	1.2	0.30	0.2	2.98	0.362	1.08	2.03	2.19
7			1.6	2.0	0.4	1.2	0.30		3.08	0.389	1.20	2.13	2.56
8			1.7	2.1	0.4				3.13	0.403	1.26	2.18	2.75
9			1.8	2.3	0.4	1.3	0.33		3.35	0.426	1.43	2.27	3.24
10			1.9	2.4	0.4				3.40	0.439	1.50	2.31	3.46
11			2.0	2.5	0.5	1.4	0.35		3.68	0.476	1.75	2.44	4.27



Source: JICA Project Team

Figure 12.9.11 Dimensions of Drainage



Source: JICA Project Team

Figure 12.9.12 Basic Arrangement of Drainage in 5 hectares-site

(2) Calculation Result

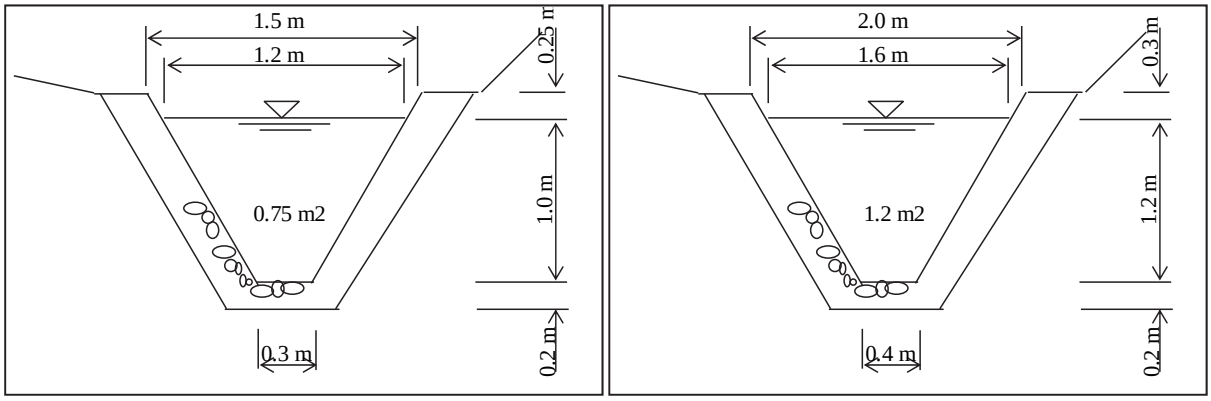
The calculation result is shown in Table 12.9.10 and the dimensions for the drainage with the 10-year probable rainfall for Nadzab and Bubia are given in Figure 12.9.13 respectively.

Table 12.9.10 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	I(mm/hr)	A(ha)	Q(m^3/s)
1			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	7	224	2.03	1.84	8.8	0.65	146.4	5.0	1.32
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	I(mm/hr)	A(ha)	Q(m^3/s)
1			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	7	224	2.03	1.84	8.8	0.65	268.8	5.0	2.43
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



Drainage for the Nadzab Development District

Drainage for all Development Districts except the Nadzab Development District

Source: JICA Project Team

Figure 12.9.13 Calculated Dimensions for the Drainages with 10-year Probable Rainfall

(3) Implementation Program and Quantity for Candidates Project

Concrete quantity of per meter for the above drainage is shown in Table 12.9.11.

Table 12.9.11 Concrete Quantity of per meter for the Drainage

District	Concrete Quantity per meter (cubic metres/m)
Na dzab Development District	0.58
Development Districts except the Nadzab Development District	0.71

Source: JICA Project Team

12.9.2.3 Flood Management Plan

The hydrological and hydraulic characteristics of the river system and the region were obtained through the site reconnaissance of the main river catchments and some future development zone proposed as of beginning of July.

(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 purpose and water utilization purpose, and consequently they have not been managed either.

Because the river management has not been performed, riverbeds of many rivers are raised with sediments from upstream, and they are meandering over and over and what is worse, there are no

river structures such as levee in almost rivers. As a result, rivers like Busu River, have caused frequent flooding disaster.

Therefore, the river management is required in order to avoid this kind of situation. 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) Flood Management

In view of the current situation, Flood Management is urgently necessary among the abovementioned objectives of the river management (Flood Management, Water Utilization and Environmental Protection) in Papua New Guinea.

The flood management plan is given in Table 12.9.12. Adoption of the plan depends critically on the hydrological and hydraulic characteristics of the river system and the region.

Table 12.9.12 Flood Management Plan

Plan	Detailed measure
(1) Reducing Flood	Dams and reservoirs/retarding basins
	Levees
	Diversion channels
	Catchment management
	Channel improvements
(2) Reducing Susceptibility to Damage	Flood plain regulation
	Development and redevelopment policies
	Design and location of facilities
	Housing and building codes
	Flood-proofing
	Flood forecasting and warning system
(3) Mitigating the Impacts of Flooding	Information and education
	Disaster preparedness
	Post flood recovery
	Flood insurance
(4) Preserving the Natural Resources of Flood Plains	Flood plain zoning and regulation

Source: JICA Project Team

In the view of (1) reducing of flood, the detailed measures will be limited by the availability of geomorphic data, materials, equipment, and in some cases the necessary skills, and the available funding. Based on these constraints, the conceivable detailed countermeasures are as follows;

1) Dams and Reservoirs/retarding basins

Dams and reservoirs or retarding basins shall be useful for the flood mitigation. Reservoirs are enlarged artificial lakes created using dams to store water and can control river flows that drains an existing body of water. They can be constructed in river valleys using dams.

Retarding basins are excavated areas installed on, or adjacent to rivers to protect properties and human lives against flooding by storing water for a limited period of a time.

They are efficient for flood control of Markham River, Bumbu River, Busu River and so on. In addition, their catchments have potential sites for the Sabo dam construction to prevent mudflow.

2) Levees

Levees are barriers to regulate and prevent floods or hold backwater from rivers, lake, or even the ocean. Riverbed excavated soil can be used as the material of dikes.

Thus levee materials can be easily obtained and they are the most common flood countermeasure.

Levees are also useful for flood control of Markham River, Bumbu River, Busu River and so on.

3) Diversion channels

Diversion channels are constructed to divert excess water from the main channel and carry it off by a different route for purposes such as flood control, municipal water supply, and irrigation.

The diversion channels construction is not applicable in the downstream catchment of Lae City. Deeper and wide channel construction is necessary to secure vast land and is expensive compared to the dike construction.

4) Channel improvement

The channel improvement is taking a channel which is deemed to be degraded in some way and attempting to improve the status of the channel through actions such that the degradation is reversed or minimized.

Channel improvement is also useful for Markham River, Bumbu River, Busu River and so on.

Channel improvement and levee construction is most applicable for the inundation area.

5) Bank Protection Work for Erosion Site

Various countermeasures such as training walls, groins, riprap, gabion baskets and vegetation will be applicable in the major river catchment. Rock groins construction needs large rock boulders but large boulders are not so much available.

Gabion baskets near the abutment of the Yalu bridge

Damaged steel H section piles with concrete panels at the Bumbu Bridge

6) Sabo Dams (Debris Barriers)

Sabo dams are built in the upstream areas of mountain streams for the purpose of controlling large amount of a debris flow without causing damages along the downstream.

The sediment transportation from the mountain areas causes the aggradation in the river course. The flood flow, mudflow or landslide due to high intensity rainfall shall transport mass volume of sediments into the river course. Sabo dam construction in the upper catchment of the mountains area makes storage of the debris flow and controls the debris toward lower catchments.

(3) Countermeasures in each rivers

The countermeasures for Markham River, Bumbu River and Busu River are as follows:

1) Calculation Conditions

i) A 50-year probable rainfall estimated in paragraph 12.9.2 is also adopted for the calculation of the discharge flow of rivers and classified as follows.

- 50-year probable rainfall of Bubia : for Bumbu River and Busu River
- 50-year probable rainfall of Nadzab : for Erap River
- Average 50-year probable rainfall of Bubia and Nadzab : for Markham River (with the exception of Erap River)

ii) Dimensions of the rivers are given in the main points based on the GIS Data.

iii) Flow capacity for each of the rivers is estimated by the use of Manning's Equation and the values shown below.

$V = 1/n \times I^{(1/2)} \times R^{(2/3)}$
$Q = V \times A$
where ; Q : Discharge flow (m3/s)
V : Velocity of flow (m/s)
n : Coefficient of roughness (See Table 12.9.13)
I : Slope of river
R : Hydraulic Radius (m)
A : Cross-sectional area of Flow (m^2)

Table 12.9.13 Coefficient of roughness

River and channel condition	Range of Manning's n
Small channel in plain without weeds	0.025 – 0.033
Small channel in plain with weeds & shrubs	0.030 – 0.040
Small channel in plain with many weeds & cobbles on bed	0.040 – 0.055
Watercourse in mountainous region with gravel & cobbles	0.030 – 0.050
Watercourse in mountainous region with cobbles & boulders	Over 0.040
Large watercourse with clay, sandy bed, slightly meandering	0.018 – 0.035
Large watercourse with cobble on bed	0.025 – 0.040

Source: Manual for River Works in Japan (Planning), Ministry of Land, Infrastructure, Transport and Tourism

iv) Rational Equation shown below is used for the calculation of discharge flow.
$Q = 1/3.6 \times f \times r \times A$
where ; Q : Design flood discharge (m3/s)
f : Runoff coefficient (See Table 12.9.14)
r : Average rainfall intensity within the time of flood concentration (r shall be calculated by using the Mononobe equation)
A : Drainage area (km^2)

Table 12.9.14 Runoff Coefficient

Classification	f
Dense urban area	0.90
General urban area	0.80
Farm land and field	0.60
Paddy field	0.70
Mountainous land	0.70

Source: Manual for River Works in Japan (Planning), Ministry of Land, Infrastructure, Transport and Tourism

The flood concentration time is the sum of the inflow time and the flow time in principle. The inflow time is shown in Table 12.9.15 and the flow time is calculated by Kraven's formula.

Table 12.9.15 Inflow Time

Area	Flow time (min.)
Mountainous drainage basin	30 / 2 km^2
Particularly steep-sloped drainage basin	20 / 2 km^2
Sewerage development district	30 / 2 km^2

Source: Manual for River Works in Japan (Planning), Ministry of Land, Infrastructure, Transport and Tourism

Kraven's formula

$T = L / W$

where; I : Slope of watercourse
W : Flood runoff velocity
L : Length of watercourse
T : Flood concentration time

Table 12.9.16 Kraven's Value

I	Over 1/100	1/100 – 1/200	Below 1/200
W	3.5 m/s	3.0 m/s	2.1 m/s

Source: Manual for River Works in Japan (Survey), Ministry of Land, Infrastructure, Transport and Tourism

2) 50-year Return Period Flow

The 50-year Return Period Flow for Markham River, Bumbu River and Busu River are shown in Table 12.9.17 respectively.

Table 12.9.17 50-year Return Period Flow

												50yrs	
River	Location	t_1(min.)	L(m)	h_{up}(m)	h_{dn}(m)	i	W	t_2(min.)	T(min.)	f	r	A	Q
Markham	Estuary	30	164,000	2,130	6	0.013	3.5	781	811	0.70	12.0	12,243	28,530
	Markham Bridge		153,500	2,130	18	0.014	3.5	731	761	0.70	12.5	12,197	29,655
	Confluence of Erap		125,000	2,130	40	0.017	3.5	595	625	0.70	8.2	7,976	12,757
Erap	Confluence of Markham		34,000	820	40	0.023	3.5	162	192	0.70	18.1	212	745
	up		24,000	820	113	0.029	3.5	114	144	0.70	21.9	178	757
Bumbu	Estuary		41,300	320	4	0.008	3.0	229	259	0.70	36.5	170	1,205
	up		29,600	320	57	0.009	3.0	164	194	0.70	44.2	132	1,134
Busu	Estuary		66,200	2,120	4	0.032	3.5	315	345	0.70	30.1	1,306	7,652
	up		12,600	2,120	102	0.160	3.5	60	90	0.70	73.8	1,272	18,263

Source: Morobe Provincial Administration

3) Flow Capacity

The flow capacity for each of the rivers is estimated and shown in Table 12.9.18. As shown in the table, the rivers mentioned below are insufficient flow capacity for the 50-year Return Period flow.

- Markham River
- Erap River (except for the downstream portion)
- Bumbu River
- Busu River (except for the upstream portion)

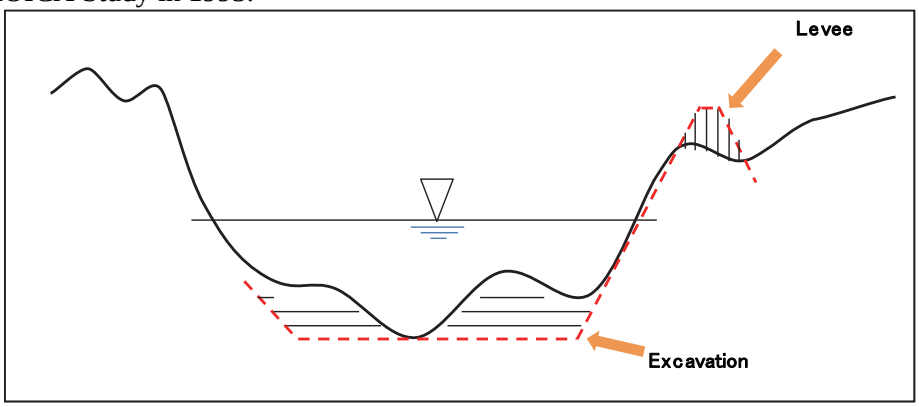
Table 12.9.18 Flow Capacity

River System	River	Location	Catchment Area (km^2)	Flow Capability (m^3/s) (present situation)		Flow Capability (m^3/s) (River Improvement)		Embankment (m^3)			Excavation (m^3)			50-year Probable Flood Q (m^3/s)
				Full Flow	Freeboard considered	Full Flow	Freeboard considered	m^3/m	Length (m)	m^3	m^3/m	Length (m)	m^3	
Markham	Markham	Estuary	12,250	3,420	470		29,120	325	1,000	324,820	3,506	1,000	3,506,140	28,550
		Markham Bridge	12,200	12,380	5,450		29,340	218	800	174,490				28,450
		Confluence of Erap River and Markham River	8,300	5,800	280		19,460	300						19,350
	Erap	Confluence of Markham River and Erap River	490	11,060	1,950									1,700
		10 km from Confluence Point	430	200	–		1,590				1,067	3,400	3,628,230	1,550
Bumbu	Bumbu	Estuary	120	410	40		1,030				260	5,000	1,297,880	940
		11.7 km from Estuary	90	820	105		790				182	7,500	1,364,140	700
Busu	Busu	Estuary	1,320	2,030	–		8,240				2,721	12,000	32,646,120	7,750
		53.6 km from Estuary	1,280	24,120	18,500									7,500

Source: Morobe Provincial Administration

4) Countermeasures for Flood Control

The countermeasures for the flood control are considered for the rivers with insufficient flow capacity for the 50-year Return Period flow.
Consideration of such that there is no short-time rainfall data, the levee and the riverbed excavation generally adopted as river improvement are considered here for the countermeasures for the flood control. Freeboard and crest width of levee are determined conforming to the values in Table 12.9.19 and Table 12.9.20, and the slope inclination of levee is 1:3 with reference to the KOICA Study in 1993.



Source: JICA Project Team

Figure 12.9.14 Image of Excavation Strategy

Table 12.9.19 Minimum Required Freeboard for Levee

Design Flood Discharge (m3/s)	Freeboard (m)
Less than 200	0.6
200 and up to 500	0.8
500 and up to 2,000	1.0
2,000 and up to 5,000	1.2
5,000 and up to 10,000	1.5
10,000 and over	2.0

Source: Government Ordinance for Structural Standard for River Administration Facilities, Japan River Association

Table 12.9.20 Minimum Required Crest Width for Levee

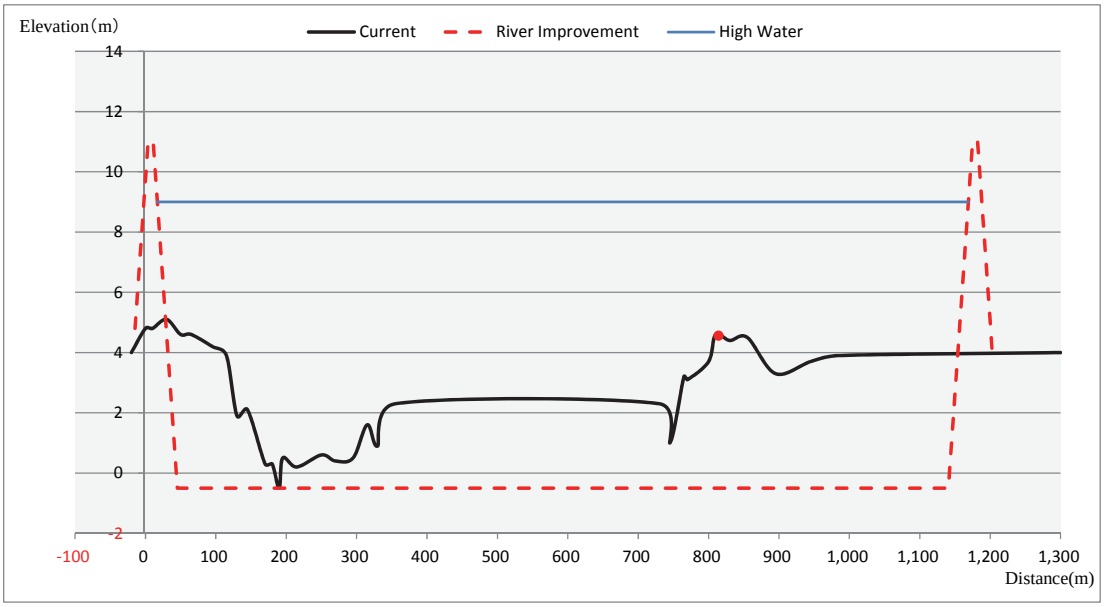
Design Flood Discharge (m3/s)	Crest Width (m)
Less than 500	3
500 and up to 2,000	4
2,000 and up to 5,000	5
5,000 and up to 10,000	6
10,000 and over	7

Source: Government Ordinance for Structural Standard for River Administration Facilities, Japan River Association

a) Markham River

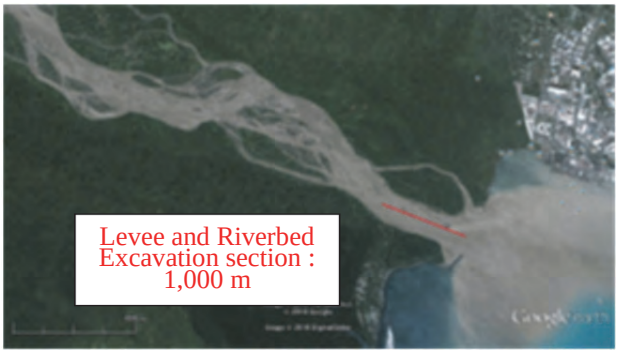
【The lower reaches of Markham River】

The lower reaches of Markham River need both the levee and the riverbed excavation as shown in Figure 12.9.15. The quantities of levee and riverbed excavation for 1,000 metres are about 330,000 cubic metres and about 3,510,000 cubic metres respectively.



Source: JICA Project Team

Figure 12.9.15 Countermeasures for Flood Control in the Lower Reaches of Markham River

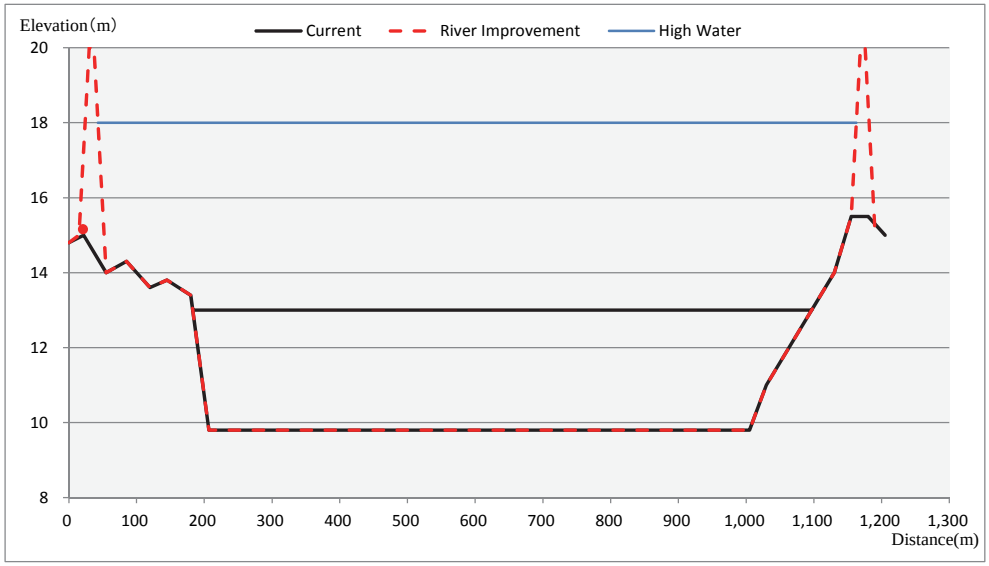


Source: JICA Project Team

Figure 12.9.16 Location of Levee Riverbed Excavation

【The right bank site of Markham Bridge in Markham River】

There are not any major facilities in the vicinity of Markham Bridge and the development planned site is limited to1-2 hectares, and moreover, this might influence Markham Bridge to replace it. Therefore, a tackle by raising about 3 metres of development site (soil volume : 60,000 cubic metres) is determined to be economic. (In the future, if this area would be developed in large-scale, it seems to be necessary to take measures such as embankments.)



Source: JICA Project Team

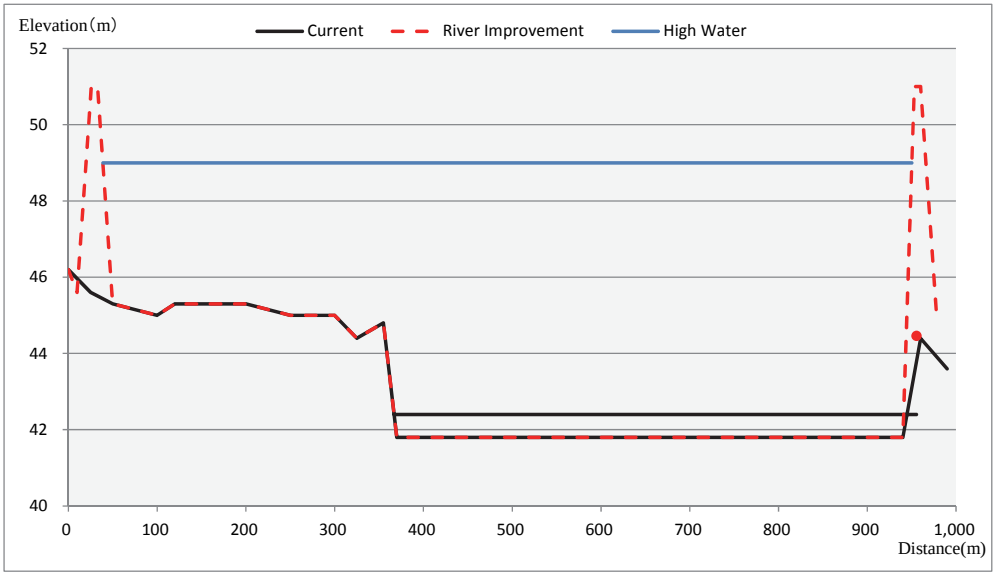
Figure 12.9.17 Countermeasures for Flood Control at Markham Bridge in Markham River

Source: JICA Project Team

Figure 12.9.18 Location of Bank Development

【The upper reaches of Markham River】

There are not any major facilities and any planned development district in the upper reaches of Markham River. Therefore, the countermeasure is not considered in this area.



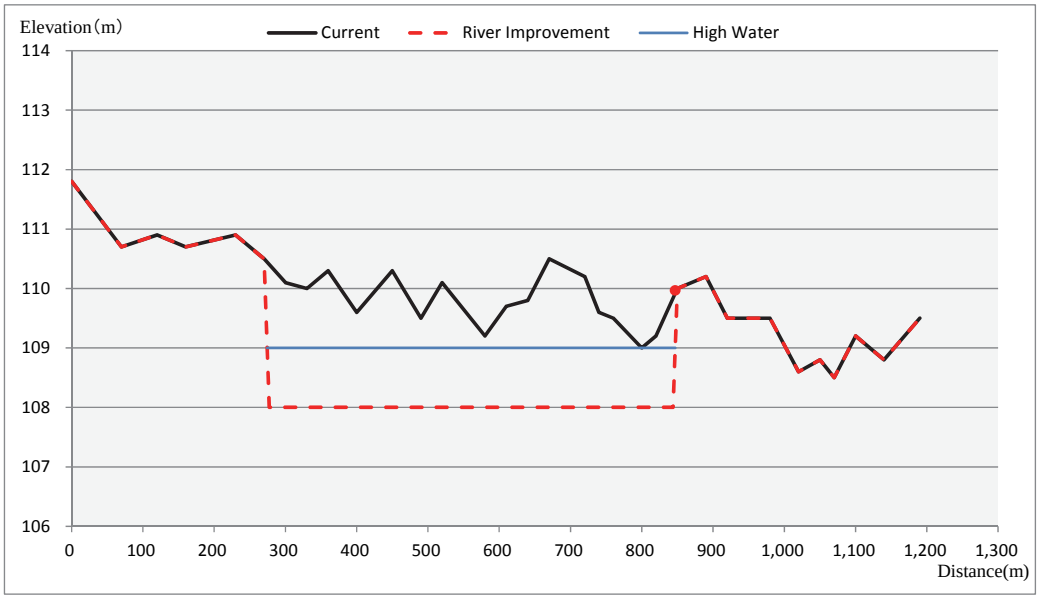
Source: JICA Projct Team

Figure 12.9.19 Countermeasures for Flood Control in the Upper Reaches of Markham River

b) Erap River

【The vicinity of Nadzab Airport in Erap River】

The vicinity of Nadzab Airport in Erap River needs the riverbed excavation as shown in Figure 12.9.20. The quantity of Riverbed excavation for 3,400 metres is about 3,630,000 cubic metres.



Source: JICA Project Team

Figure 12.9.20 Countermeasures for Flood Control in the Vicinity of Nadzab Airport in Erap River

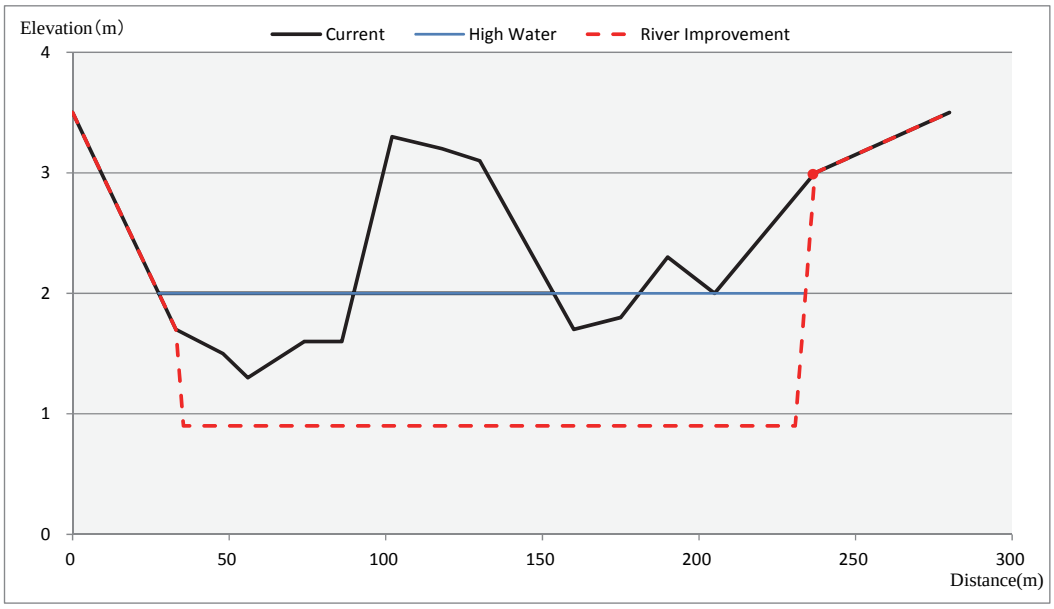
Source: JICA Project Team

Figure 12.9.21 Location of Riverbed Excavation

c) Bumbu River

【The lower reaches of Bumbu River】

The lower reaches of Bumbu River needs the riverbed excavation as shown in Figure 12.9.22. The quantity of riverbed excavation for 5,000 metres is about 1,300,000 cubic metres.
Because river improvement in the downstream is prior to the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.



Source: JICA Project Team

Figure 12.9.22 Countermeasures for Flood Control in the Lower Reaches of Bumbu River

Source: JICA Project Team

Figure 12.9.23 Location of Riverbed Excavation

【The upper reaches of Bumbu River】

The upper reaches of Bumbu River needs the riverbed excavation as shown in Figure 12.9.24. The quantity of Riverbed Excavation for 7,500 m is about 1,370,000 cubic metres.

Because river improvement in the downstream is prior to the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.

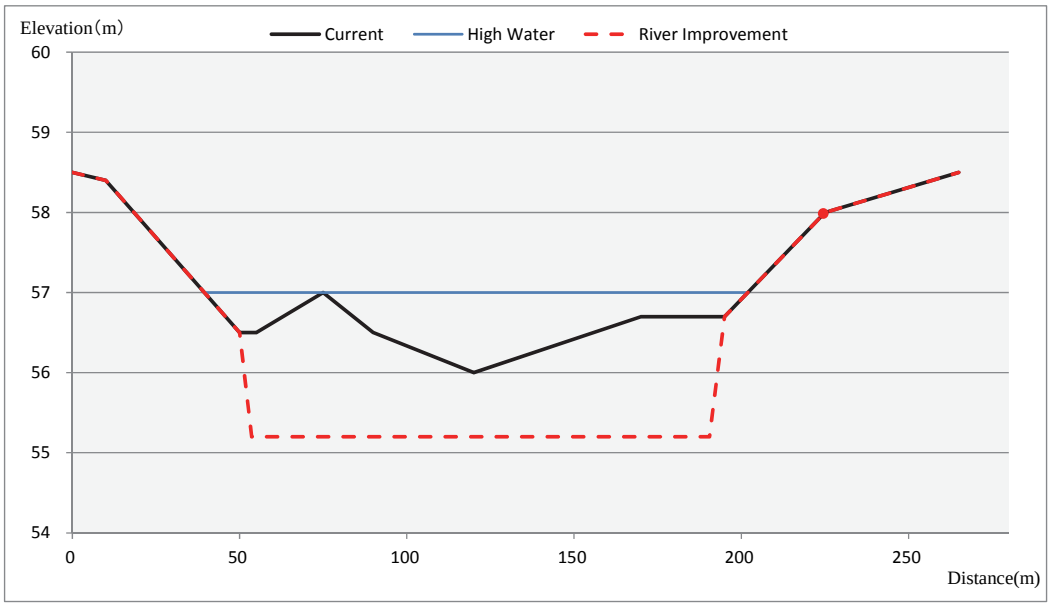


Figure 12.9.24 Countermeasures for Flood Control in the Upper Reaches of Bumbu River

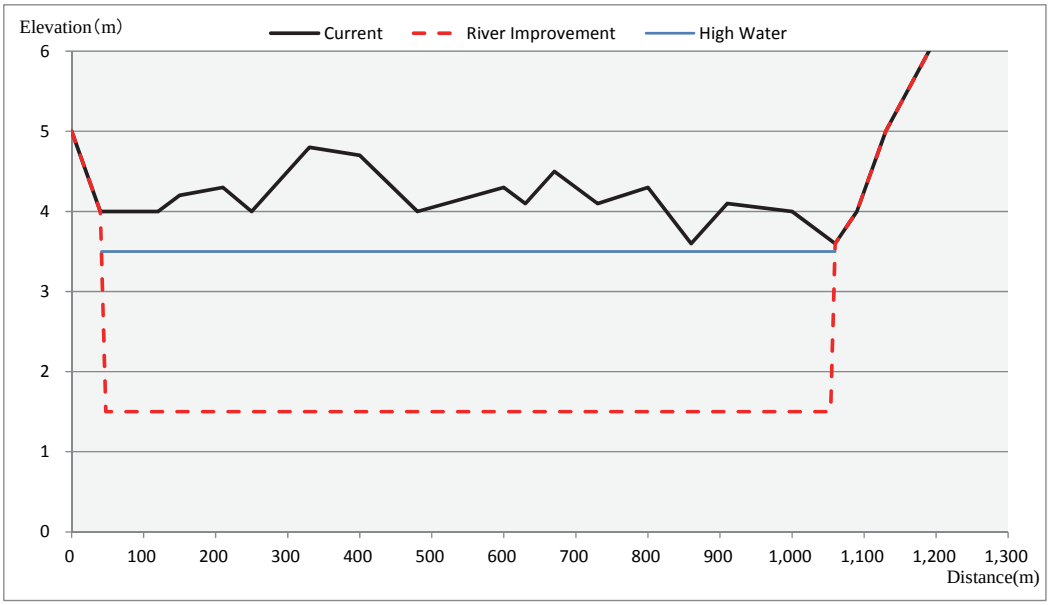
Source: JICA Project Team

Figure 12.9.25 Location of Riverbed Excavation

d) Busu River (except for the upstream portion)

【The lower reaches of Busu River】

The lower reaches of Busu River needs the riverbed excavation as shown in Figure 12.9.26. The quantity of riverbed excavation for 12,000 metres is about 32,650,000 cubic metres.



Source: JICA Project Team

Figure 12.9.26 Countermeasures for Flood Control in the Lower Reaches of Busu River

Source: JICA Project Team

Figure 12.9.27 Location of Riverbed Excavation

12.9.3 Disaster Management & Storm Water Drainage Projects

(1) Disaster Management & Storm Water Drainage Projects

The proposed projects so far are summarized below.

Table 12.9.21 Flood Management Projects

No.	Project Title	Project Outline	Proposed Location
SD-1	River Improvement Project in the lower reaches of Markham River	Since Markham River has not been maintained, the risk of flood damage is expected that the ever-increasing. The project includes the following scopes: • Construction of embankment (length: 1,000 metres, volume: about 330,000 cubic metres) • Excavation of riverbed (length: 1,000 metres, volume: about 3,510,000 cubic metres)	The lower reaches of Markham River
SD-2	Ground Raising Project in the right bank site of Markham Bridge in Markham River	Since Markham River has not been maintained, the risk of flood damage is expected that the ever-increasing. Although, the embankment of 180,000 cubic metres is necessary to be constructed, there is any major facilities in the vicinity of Markham Bridge and the development planned site is limited to1ha – 2 hectares, and moreover, this might influence Markham Bridge to replace it. Therefore, a tackle by raising about 3 metres of development site (soil volume : 60,000 cubic metres) is determined to be economic. The project includes the following scopes: • Raising the ground level (area: 2 hectares, soil volume: about 60,000 cubic metres)	The right bank site of Markham Bridge

No.	Project Title	Project Outline	Proposed Location
SD-3	River Improvement Project in Erap River	Since Erap River has not been maintained, the risk of flood damage is expected that the ever-increasing. The project includes the following scopes: • Excavation of riverbed (length: 3,400 metres, volume: about 3,630,000 cubic metres)	The vicinity of Nadzab Airport
SD-4	River Improvement Project in the lower reaches of Bumbu River	Since Bumbu River has not been appropriately maintained, the risk of flood damage is expected that the ever-increasing. The project includes the following scopes: • Excavation of riverbed (length: 5,000 metres, volume: about 1,300,000 cubic metres) Because river improvement in the downstream is prior to the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.	The lower reaches of Bumbu River
SD-5	River Improvement Project in the upper reaches of Bumbu River	Since Bumbu River has not been appropriately maintained, the risk of flood damage is expected that the ever-increasing. The project includes the following scopes: • Excavation of riverbed (length: 7,500 metres, volume: about 1,370,000 cubic metres) Because river improvement in the downstream is prior to the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.	The upper reaches of Bumbu River
SD-6	River Improvement Project in the lower reaches of Busu River	Since Busu River has not been appropriately maintained, the risk of flood damage is expected that the ever-increasing. The project includes the following scopes: • Excavation of riverbed (length: 12,000 metres, volume: about 32,650,000 cubic metres)	The lower reaches of Busu River

(2) Implementation Program and Project Cost

Implementation Program shown in Table 12.9.22 is estimated roughly.

The each construction cost is estimated using the tabulated unit cost in Table 12.9.23 and is shown in Table 12.9.24 The Project cost is calculated as shown in Table 12.9.25 taking into account the engineering cost, the administration cost, the contingencies and the tax.

Table 12.9.22 Implementation Program

	project title	proposed location	Development Cost (Mil.PGK)	Development Scale	Expected Implementation Agency	Schedule (to 2050) 2017 -2020 -2025 -2050	Remark
SD-1	River Improvement in the lower reaches of the Markham River	The lower reachs of Markham River	215.58	50-year return period	Department of Works, PNG		
SD-2	Ground Raising	The right bank site of the Markham Bridge in the Markham River	5.57	50-year return period	Department of Works, Morobe		
SD-3	River Improvement of the Erap River	The Erap River	191.25	50-year return period	Department of Works, PNG		
SD-4	River Improvement of the lower reaches of the Bumbu River	The lower reaches of the Bumbu River	68.49	50-year return period	Department of Works, PNG		
SD-5	River Improvement of the upper reaches of the Bumbu River	The lower reaches of the Bumbu River	72.18	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	1,720.22	50-year return period	Department of Works, PNG		
Total Cost			2,273.29				

Source: JICA Project Team

Table 12.9.23 Unit Cost

Classification	Unit Cost (PGK/cubic metres)	Remarks
Embankment	67	Including earth brought from an area forming the soil-pit.
Excavation	38	The land excavation in the dry season.

Source: JICA Project Team

Table 12.9.24 Construction Cost

No.	River Improvement Project		Quantity (cubic metres)				Unit Cost (PGK/cubic metres)	Cost (PGK)			
			2021-2025	2026-2050	2051-	Total		2021-2025	2026-2050	2051-	Total
1	River improvement in the lower reaches of Markham River	Embankment	-	165,000	165,000	330,000	67	-	11,055,00	11,055,000	22,110,000
		Excavation	-	1,755,000	1,755,000	3,510,000	38	-	66,690,000	66,690,000	133,380,000
2	Ground raising at the right side of Markham Bridge in Markham River	Embankment	60,000	-	-	60,000	67	4,020,000	-	-	4,020,000
		Excavation	-	-	-	-	38	-	-	-	-
3	River improvement of Erap River	Embankment	-	-	-	-	67	-	-	-	-
		Excavation	1,210,000	2,420,000	-	3,630,000	38	45,980,000	91,960,000	-	137,940,000
Markham River		Embankment	60,000	165,000	165,000	390,000	67	4,020,000	11,055,000	11,055,000	26,130,000
		Excavation	1,210,000	4,175,000	1,755,000	7,140,000	38	45,980,000	158,650,000	66,690,000	271,320,000
4	River improvement of the lower reaches of Bumbu River	Embankment	-	-	-	-	67	-	-	-	-
		Excavation	433,333	866,667	-	1,300,000	38	16,466,666	32,933,333	-	49,399,999
5	River improvement of the upper reaches of Bumbu River	Embankment	-	-	-	-	67	-	-	-	-
		Excavation	-	685,000	685,000	1,370,000	38	-	26,030,000	26,030,000	52,060,000
Bumbu River		Embankment	-	-	-	-	67	-	-	-	-
		Excavation	433,333	1,551,667	685,000	2,670,000	38	16,466,666	58,963,333	26,030,000	101,459,999
6	River improvement of the lower reaches of Busu River	Embankment	-	-	-	-	67	-	-	-	-
		Excavation	-	8,162,500	24,487,500	32,650,000	38	-	310,175,000	930,525,000	1,240,700,000
Total		Embankment	60,000	165,000	165,000	390,000	67	4,020,000	11,055,000	11,055,000	26,130,000
		Excavation	1,643,333	13,889,167	26,927,500	42,460,000	38	62,446,666	527,788,333	1,023,245,000	1,613,479,999

Source: JICA Project Team

Table 12.9.25 Project Cost

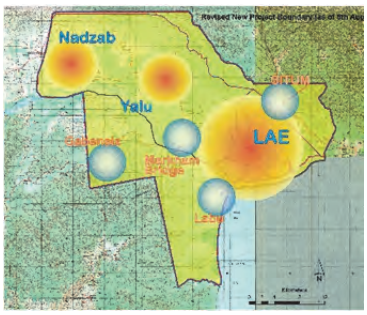
(unit:PGK)

	Item	The lower reaches of Markham River	The right bank of Markham Bridge in Markham River	The vicinity of Nadzab Airport in Erap River
A	Construction Cost	155,490,000	4,020,000	137,940,000
B	Engineering Cost (A x 10%)	15,549,000	402,000	13,794,000
C	Administration Cost (A x 5%)	7,774,500	201,000	6,897,000
D	Contingencies ((A+B+C) x 10%)	17,881,350	462,300	15,863,100
E	Tax ((A+B+E) x 10%)	18,892,034	488,430	16,759,710
Total		215,586,884	5,573,730	191,253,810
	Item	The lower reaches of Bumbu River	The upper reaches of Bumbu River	The lower reaches of Busu River
A	Construction Cost	49,399,999	52,060,000	1,240,700,000
B	Engineering Cost (A x 10%)	4,939,999	5,206,000	124,070,000
C	Administration Cost (A x 5%)	2,469,999	2,603,000	62,035,000
D	Contingencies ((A+B+C) x 10%)	5,680,999	5,986,900	142,680,500
E	Tax ((A+B+E) x 10%)	6,002,098	6,425,290	150,745,049
Total		68,493,094	72,181190	1,720,230,549

Source: JICA Project Team

12.10 Recreational Facilities & Amenities

Main concern in this section for urban amenities and recreational facilities is park and open space development for the public to use. The development plan for Lae-Nadzab Area in the next ten years till 2025 mainly focuses on the Lae Urban Area, Yalu area and Nadzab Airport area. Nadzab Airport development plan and its feasibility study will be implemented later, and it should take some more time for full scale operation of renewed airport facility, so that major population increase in the Airport area will not be expected during the Project target year. Later stage of the Project target year will see initial development of spill over effect to the surrounding rural areas, but sudden increase of population is not expected either in these areas, such as Labu, Gabensis and east of Lae Urban Area. Thus, major focus for the recreational facilities and amenities development will consider Lae Urban Area and Yalu.



Source: JICA Project Team

Figure 12.10.1 Possible Park Development Areas

Accordingly, such public facility development will be considered in these two areas, while the existing public facilities listed in the Table 6.10.8. There are several public parks and sports ovals developed, but some are not well utilized for public use, therefore certain kind of public park use regulation and program should be organized to maximise the usage. Figure 12.10.1 illustrates possible areas of development (Orange circles for earlier development, and blue circles for later development). The necessary facilities for development will be calculated based on the urban development framework with population growth to identify the needs and sizes.

(1) Issues of ensuring the park and green space

Lae City, until today not only as an industrial city, but also having a legacy where it has been referred to as the "Garden City" in the colonial era, is rich in terms of both quality and quantity of colourful parks.

In addition, even in the rural area outside of Lae City, open spaces can be seen everywhere taking advantage of the customary land owned by each tribe. Although occasionally there are also integrated open spaces in church premises by spread of Christianity, overall maintenance level as "vacant lot" is simply in the low status.

However, small-scale urban area parks, street corner open spaces, etc. almost do not exist anymore. At the same time, although large recreation in wide-area to be mainly used routinely for family are not seen is probably because in the lifestyle of Papua New Guinea the need may have not occurred.

In the urban development plan of the future, to ensure wide recreation area effective for future, using the image of The Garden City in Lae City for expansion and inheritance of wide area is sufficient by continually ensuring small-scale urban area parks, street corner open spaces, etc. by every little chance to find.

(2) The needs for the park maintenance

Here, first to check the Urban Subdivision (and Road) Design Standards due to Section 37 (Recreation Areas) of the PNG-Physical Planning Regulation 2007.

According to the report, for 1000 population (i.e. 100 to 200 units/households) 4 hectares (which is 40 square metres/person) requirement is stated. However, as the applicable criteria for small-scale residential development, for the population of 1,000 (200 units estimating 5 persons/unit), stating national characteristic of State Land and Customary Land, to explore the possibility of Affordable Housing of the future by the civil cooperation (public collaboration), the impression is really too strict as compared to the world level.

Reference ①

It is more than 10 times of Japan, and equivalent is at high level even comparing to the world.

Standard of Japan's land readjustment: park is considered 3% of total land use area, which is 3square metres/person as a park area.

The reason for this is explained by two simple calculations. First, estimates by the first one.

In small residential area of only 1,000 population (200 units estimating 5 persons/unit), population density of 100 people/hectare (20 units/hectare) in detached residential area and 500 people/hectare (100 units/hectare) in collective residential area, in other words, in the area of land use in case of 500 square metres/ units for detached residential and 100 square metres/ units collective residential, total land use area for collective residential will be 2 hectares and detached residential will be 10 hectares.

In such case, Section 37 Recreation Areas standard "4ha" of the PNG-Physical Planning Regulation 2007 is unrealistically too large. Relatively, if it is at most not about "1 hectare", it would prevent the implementation of the expected Affordable Housing Project by participation of private developer.

Reference ②

This survey area is 290 hectares-3%, Lae 280 hectares (but it might include the Ahi ...) - Lae City 8%

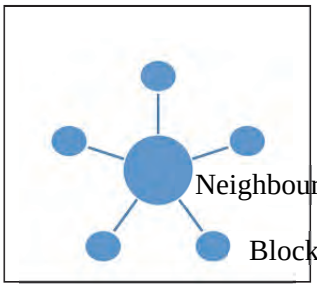
Land Use Status Survey Lae population 93,000 people

Open Space Lae 280 hectares / 93,000 people = 30 square metres/person ≦ 40 square metres/person

Then, in neighbourhood model of a little more than 100 hectares is estimated by of the second calculation.

Model neighbourhood of Clarence Arthur Perry is a community model that focuses on about 100 hectares and about 10,000 population with elementary schools and churches, and several types of parks for everyday life are also arranged. In the smallest model, about 1-2 hectare city block park in several locations, 2-3 hectare neighbourhood park in one place which makes total of 3-5 hectares that is about 3-5% in the total land use area, and 3-5 square metres/person park area.

In this way, Section 37 Recreation Areas standard (40 square metres/person) of the PNG-Physical Planning Regulation 2007 is at a considerably higher level.

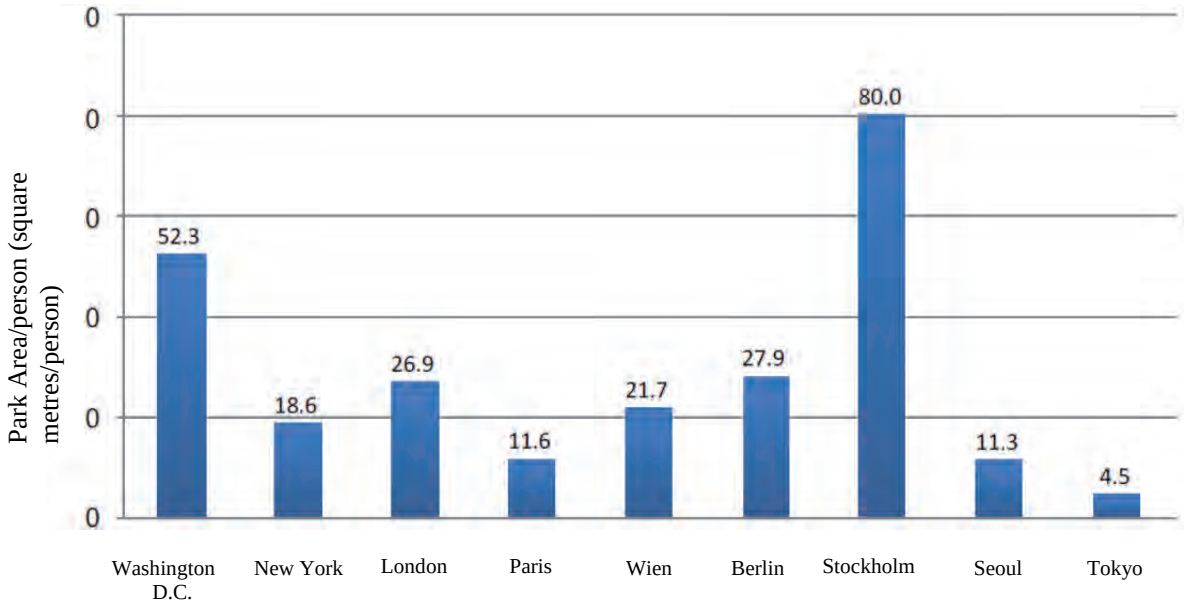


Neighbourhood Park:2 hectares

Block Parks:sub total :1ha

Perry's Neighbourhood Unit

In this project, open space is redefined that parks, botanical garden, greenery area, sport ground, grave yards and other open spaces in a broader sense are counted. Open space includes



Source: MLT, GOJ

Figure 12.10.2 Park Area per Person in the World

From the above, to understand and apply the measures of Section 37 Recreation Areas standard of PNG-Physical Planning Regulation 2007 for the entire city, slightly higher "about 5-10 square metres/person" is assigned to a familiar park of a neighbourhoods with the population of 10,000 people about (about 100 hectares) , and "about 10-15 square metres/person" is assigned to a little larger district park (Ward Park) by each sector of Lae metropolitan area for every several tens of thousands population. and the rest assign as the Central Park, general (public) park, or wide area recreation green space, etc.

The parks shall be systematically allocated with the goals of 30-40 square metres/person for parks and greenery and 50-60 square metres/person for open space including parks, botanical garden, greenery area, sport ground, grave yards and other open spaces. The composition rate of parks and greenery as urban facility and open space are 10% and 15% in the coloured area of Physical Planning Area respectively.

The areas with good scenery generally have rationale to be protected from viewpoints of recreation function and also disaster prevention function. Those areas include water surface; river, lake and canal, waterfront; seashore, riverbank, lakeside, mountain forest, and moor and designated as a protected area other than parks and greenery area as urban facility.

In the Project Area following area are nominated.

- - Waterfront area including lagoons in Labu
- - Seashore area between Markham River to Busu and Bupu Rivers
- - Area near Lake Wamum
- - Atzera Range near Lae City
- - Herzog Mountains near Markham River
- - Upper stream area of Busu River

Not precise zoning for scenery protection is defined in PNG, combined zoning of conservation and open space is deemed as operational application of Physical Planning Regulation.

12.11 Social Services

12.11.1 Development Direction

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. Since the level of economy in Lae-Nadzab Area is relatively weak in general aspect and fundamental social services are not properly provided, basic facilities and services are considered instead of providing advanced public services.

- Primary, Secondary Schools and other Higher Education Programs
- Healthcare Facilities (Aid Posts and Health Centres)
- Public Parks (Recreational, Sports and Green Landscaping Concept)
- Community Centres
- Police Stations
- Sports Facility Expansion (under LULLG's Development Plan)

Each development plan should come up with development goal and targeted index of the development to deliver appropriate master plan for the Lae-Nadzab region. The following table illustrates goals and target index of developments.

Table 12.11.1 Goals and Target Index of Development

Development	Goals	Target Index of Goals
Provide equal and quality educational opportunity to children	Ensure accessibility to each school	➢ Catchment area radius of each school: 3 miles ➢ Travel distance and time: 1 hr. maximum
	Ensure quality of educational services provided to students	➢ Ratio of teachers to students in each class: 1 teacher/40 students ➢ Types of classroom provided: general Classrooms, library, toilets
Provide better & appropriate opportunity with healthcare services	Ensure accessibility to each healthcare facility	➢ Catchment area radius of each healthcare facility: 4 miles ➢ Travel distance and time: 1 hr. maximum
	Ensure quality of healthcare services provided to local people	➢ Population ratio for each facility: 1 CHP/6000 population ➢ Number of healthcare workers and officers for each facility: minimum 3 ➢ Number of ambulance provided: 1~2
Improve local recreational opportunity and services	Ensure balanced distribution of pubic recreational services	➢ Number of public parks: 1 park per community ➢ Catchment area radius for each facility: 1 mile
	Create safe local public facilities	➢ Level of security: protected with police watch ➢ Number of security officials to attend: 1 per 1 park
Improve local community services	Create accessible and effective community facilities	➢ Catchment area radius for each facility: 4 miles ➢ Population ratio to facility area: 5000

Development	Goals	Target Index of Goals
Improve community or regional market opportunity	Create accessible and effective market	➢ Catchment area radius for each market: 4 miles ➢ Travel distance and time: 1 hr.
	Ensure security and safety of market	➢ Level of security: protected with police watch ➢ Number of security officials to attend: 1~2
Improve security and safety of the region	Ensure security and safety level	➢ Population ratio per police station: 1000 per station ➢ Number of police officer per each station: 3 ➢ Catchment area radius per station: 2 mile

Source: JICA Project Team

12.11.2 General Development Plans/Projects

Following the sector development goal and development index described above, general development plan for each facility with year 2025 forecast is discussed hereafter based on the Socio-Economic Analysis particularly population forecast in each Ward.

(1) School Development Plan

1) Primary Schools

The enrolment of primary schools in the Project Area is still low and has large possibility of improvement with student increase to attend education. Since there are many student age children having difficulties to attend schools due to various reasons, the primary school development and service improvement is the most urgent tasks to achieve in educational services in the Project Area. On the basis of LLG and Ward based population forecast and the result of the household survey in age group population, the student population forecast in 2025 was calculated by following steps.

Primary school age population of grade-3 to grade-8 is approximately 18% of population in the Project Area, and this average ratio is applied to calculate total number of students possibly attending primary schools in each Ward of the Project Area. Since the population forecast considers social impact based increase or decrease, the calculated number of students is concerned of total number. Thus grade based population is not calculated due to uncertainty of socially affected population move. Accordingly, the required number of classrooms in each Ward was calculated regardless of grade proportion.

Based on the school data provided by the District Administrations, the number of existing classrooms for each school is adopted to calculate the required number of new classrooms in each Ward. According to the Ward boundary map and school location map provided by the MPA, specific total number of classroom for each Ward is identified. The number of existing classrooms is subtracted from the total number of classroom required according to the student population in order to identify newly required number of classroom. The tables hereafter illustrate required number of classrooms in each Ward.

Where a new school is considered for development, minimum six classrooms should be provided as there is large number of students expected. Where a new school is required but less student population is expected, smaller number of classrooms will be provided considering room-share teaching. Since population flow is not definite and fixed, a few classrooms are considered in addition to the actual required numbers to secure flexibility against population change. Especially for new schools, certain number of classrooms should be provided to fulfil six grade completion without shortage of rooms, thus minimum of six and 12 can be considered with best economical consideration given.

Current classroom environment indicates that many of classrooms are populated by over 50 students, while Japanese school planning guideline and regulation notes that the number of students per classroom should be 40 at most. Universal Basic Education Plan 2010-2019 of PNG (UBE Plan) suggests 35 to 37 per classroom. However, unit number is set as average unit of 40 for each

classroom for the next ten years, since less student density requires more rooms thus more teachers.

Number of teachers to be allocated is also calculated based on the forecasted number of classrooms for each Ward, applying average teacher-student ratio that is one teacher per 35 students (maximum pupil teacher ratio of UBE Plan is 35.3) with adjustment. Existing schools only require number of teachers equal to the number of classrooms to be provided. Since not only homeroom teachers but also specialty teaching staffs as well as administrative teachers should be counted.

Detailed study and calculation for each school with specific required numbers of classrooms[1] and teachers should be made during the detailed design stage together with site decision for new schools in each Ward under the implementation by the Department of education and its local agency. Other facilities are planned as follows.

e) Toilet Facility[2]

At the target year of 2025, all schools should be equipped with toilet facilities with at least one toilet stall per 100 students. Teacher's toilet facility will also be provided.

f) Library[3]

Any schools where no library is set, one library should be provided with EQTV program. By 2025 all primary schools should be with a library and good enough amount of books for students.

g) Principal and Teacher's Rooms[4]

Teacher's room will be provided for shared use and office machine, such as copy machines etc. to be installed for safe and convenient use. This may also include storage space for educational materials. Principal's room will also be set for each school by 2025.

h) Water tank for multiple use

As many schools are installed with commonly sized water tank to store rainwater for use, calculated number of tanks should be installed for all primary schools by 2025.

i) Teachers Quarters[5]

Many teachers are appointed for the specific period of time to teach at a school and move around schools, thus they require housing facilities. These should also be provided with PNG standard set by the Department of Education.

Table 12.11.2 Labuta LLG Primary School Student Population Forecast in 2025

LLG Name	Ward No.	Ward Name	Future Population		18.0%	Student Total	Facility Condition	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built	Additional No. of Teachers
			2025	Ward Total							
Labuta (L)	12	MUSOM/TALE	2,237	2,237	403	403	New	10.1	0	12	12
	13	SITUM	6,597	6,597	1,187	1,187	with SITUM	29.7	22	8	8

Source: JICA Project Team

Table 12.11.3 Nabak LLG Primary School Student Population Forecast in 2025

LLG Name	Ward No.	Ward Name	Future Population		18.0%	Student Total	Facility Condition	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built	Additional No. of Teachers
			2025	Ward Total							
Nabak (N)	13	HOBU	1,167	1,167	210	210	New	5.3	0	6	6

Source: JICA Project Team

[1] Construction cost of one (1) typical classroom is estimated at approximately 300,000 PGK based on the information provided by the Department of Education, PNG, and double decked two (2) classroom structure is at 500,000 PGK.
[2] Construction cost of one (1) typical toilet structure with three (3) stalls and hand-wash basins is at approximately 150,000 PGK with water tank installation based on the other school facility construction costs.
[3] Construction cost of one (1) library is estimated at 1.5 times of one (1) typical classroom construction cost.
[4] One (1) teachers' room or principal's room construction cost is estimated at the same cost of one (1) classroom construction
[5] Construction cost of one (1) typical teacher's quarter is estimated at approximately 300,000 PGK based on the information provided by the Department of Education, PNG.

Table 12.11.4 Lae Urban LLG Primary School Student Population Forecast in 2025

LLG Name	Ward No.	Ward Name	Future Population		18.0%	Student Total	Facility Condition	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built	Additional No. of Teachers
			2025	Ward Total							
Lae Urban (LU)	1	ERIKU/ BUNDI	3,407	30,466	613	5,484	with Buimo and Markam Road	137.1	55	82	82
	1	ERIKU/ BUNDI	846		152						
	1	ERIKU/ BUNDI	2,809		506						
	1	ERIKU/ BUNDI	2,010		362						
	1	ERIKU/ BUNDI	16,434		2,958						
	1	ERIKU/ BUNDI	4,961		893						
	2	TOP TOWN	2,135	12,922	384	2,326	with Lae St. Pauls and Huonville	58.1	68	No Increase	No Increase
	2	TOP TOWN	818		147						
	2	TOP TOWN	8,967		1,614						
	2	TOP TOWN	1,002		180						
	3	MAIN MARKET	991	12,693	178	2,285	with St. Martins and Milfordhaven	57.1	30	28	28
	3	MAIN MARKET	2,229		401						
	3	MAIN MARKET	905		163						
	3	MAIN MARKET	8,568		1,542						
	4	HAIKOST	10,911	13,922	1,964	2,506	with Four-Mile, St. Mary's and Haikoast	62.7	57	6	6
	4	HAIKOST	3,011		542						
	5	UNITECH	3,778	16,455	680	2,962	with Butibam, St. Patricks and Lanakapi Lutheran	74.0	50	24	24
	5	UNITECH	12,677		2,282						
	6A	EAST TARAKA	4,750	4,750	855	855	with Gantom	21.4	23	No Increase	No Increase
	6B	WEST TARAKA	7,544	7,544	1,358	1,358	with Taraka	33.9	30	6	6
	6C	IGAM	4,251	4,251	765	765	with Igam and Tent City	19.1	12	8	8

Source: JICA Project Team

Table 12.11.5 Ahi Rural LLG Primary School Student Population Forecast in 2025

LLG Name	Ward No.	Ward Name	Future Population		18.0%	Student Total	Facility Condition	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built	Additional No. of Teachers
			2025	Ward Total							
Ahi (A)	1	HENGALI	4,540	4,540	817	817	New	20.4	0	21	23
	2	BUTIBAM WEST	2,283	2,283	411	411	New	10.3	0	12	12
	3	BUTIBAM EAST	1,862	1,862	335	335	New	8.4	0	10	10
	4	WEST BUKO	669	669	120	120	New	3.0	0	3	6
	5	EAST BUKO	1,341	1,341	241	241	New	6.0	0	6	7
	6	WEST WAGANG	No Increase	N/A	N/A	N/A	N/A	No Increase	N/A	No Increase	No Increase
	7	EAST WAGANG	4,378	7,346	788	788	New	19.7	0	20	23
	8	YANGA	1,883	7,254	339	1,306	with Bowali	32.6	16	18	18
	8	YANGA	5,371		967						
	9	GAWANG	5,820	5,820	1,048	1,048	with Amba	26.2	30	No Increase	No Increase

							Dem				
	10	BUSURUM	1,359	1,359	245	245	New	6.1	0	6	7
	11	MALAHANG	574	574	103	103	New	2.6	0	3	6
	12	BUSU-POASANG	4,948	4,948	891	891	New	22.3	0	24	25
	13	POAHOM	9,000	9,000	1,620	1,620	New	40.5	0	42	46
	14	LIMKI	14,326	14,326	2,579	2,579	New	64.5	0	66	74
	15	KAMKUMUNG	2,884	2,884	519	519	New	13.0	0	13	15
	16	POASUM	18,762	18,762	3,377	3,377	New	84.4	0	84	96
	17	BUMAYONG	4,911	10,000	884	1,800	with Hobu	45.0	6	40	40
	17	BUMAYONG	2,383		429						
	17	BUMAYONG	2,383		429						
	17	BUMAYONG	323		58						

Source: JICA Project Team

Table 12.11.6 Wampar LLG Primary School Student Population Forecast in 2025

LLG Name	Ward No.	Ward Name	Future Population		18.0%	Student Total	Facility Condition	Required No. of C.R.	Existing No. of C.R.	No. of C.R. to be Built	Additional No. of Teachers
			2025	Ward Total							
Wampar (W)	3	GABENSIS	1,937	1,937	349	349	with Gabensis	8.7	12	No Increase	No Increase
	4	UMSIS	1,223	1,223	220	220	New	5.5	0	6	6
	5	MARKHAM BRIDGE	1,840	1,840	331	331	New	8.3	0	10	10
	6	LABUTALE	No Increase	N/A	N/A	N/A	with Labutale	No Increase	6	No Increase	No Increase
	7	LABUMITI	1,266	1,266	228	228	with Labumiti	5.7	6	No Increase	No Increase
	8	LABUBUTU	1,734	1,734	312	312	with Labubutu	7.8	6	2	2
	9	GAWANG/5 MILE	10,911	10,911	1,964	1,964	New	49.1	0	50	56
	10	ST JOSEPH	10,292	10,292	1,852	1,852	New	46.3	0	48	53
	11	AWILLUNGA	11,058	11,058	1,990	1,990	New	49.8	0	50	57
	12	BUBIA	6,773	6,773	1,219	1,219	with Christ King and Bubia	30.5	30	No Increase	No Increase
	13	BUSANIM	5,961	5,961	1,073	1,073	New	26.8	0	30	31
	14	YALU	4,695	4,695	845	845	with Muya	21.1	12	9	9
	15	MUNUM	2,823	2,823	508	508	with Munum	12.7	8	5	5
Wampar (W)	16	NASUAPUM	1,482	1,482	267	267	with Nasuapum	6.7	8	No Increase	No Increase
	17	GAPSONGKEG	8,290	8,290	1,492	1,492	with Gabmazung	37.3	12	26	26
	18	NAROMANGKI	1,710	1,710	308	308	New with Erap Boys Town	7.7	2	6	6

Source: JICA Project Team

According to the primary school development standard of Japan, one primary school should be provided for each 1,600 to 2,000 households. Currently primary schools in Lae-Nadzab Area should cover over 5,000 to 7,000 populated catchment area or even much larger communities. Schools in the Project Area have issues of educational environment as well as accessibility, especially rural areas. Many school teachers expressed that the catchment area of school is so large and radius of walking distance extends over 5 miles and some are more than 10 miles. In order to reduce walking distance and time of students as well as to provide better accessibility and safe commuting environment, one primary school should be provided in 3 miles (about 5 kilometres

maximum, but 4 kilometres maximum is more recommendable) in less populated rural areas for the target year 2025.

Longer distance to schools could be a major hindrance for attendance, and the negative impact to the economy at wider concern should occur under the lower school enrolment rate. Today, some communities or villages having long-distance oriented difficulties have developed their own community schools asking for missionary funds, for instance. For the 2025 development target, these community schools shall also be publicly funded, operated and maintained, while existing schools will be expanded or new schools are constructed. Where financially difficult to construct new schools within the recommended radius, school bus services to be applied for long distance walking students that could improve accessibility and attendance rate.

2) Secondary Schools

According to the Final Enrolled Education data shown in Chapter 4, enrolment for secondary schools in the Project target area is only about 12% while primary school enrolment shows 36%. In this view, improve primary school level services to increase the enrolment is the first task through the Project target year till 2025 so that by the time more number of students will demand for next education level to access. Therefore, improvement of existing secondary school facilities should be the priority including accessibility improvement 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 may be considered where more population growth is expected under the Project economic and industrial development which drives more resident settlement maybe in mid-to-long term development period considering the year 2050.

3) Development for long term stage by 2050

School facility should be in general constructed according to actual population increase, so that time-by-time social survey should be conducted to identify population-up-to-date to calculate the number of required classrooms. According to the population forecast by 2025 and required number of classrooms, the development under the master plan implementation should take place. Accordingly, with future social survey data, development of further required classrooms will be implemented beyond 2025. Market price for construction may also escalate so that it is recommended to conduct population survey by MPA in every five-year period.

4) Development of Vocational Schools and Technical Colleges

- Vocational Schools

  Vocational school development should be considered as a major part of industrial development in the long term development vision. There are many people in the region, however they have not had enough access to gain necessary knowledge and technical skills to participate in higher level production businesses or even simple task works. One reason is, of course, a lack of variety and more educational opportunities to the people, and the second reason is that there was not much of need in such area of training and work skill education due to consumption based living style in the region.

  Vocational schools may be located nearby industrial development areas or existing school sites to maximize their effective curriculum based on immediate real training of, for instance, mechanical repair works, metal works and cultivation works.

  In order to support SME, vocational schools may also become a significant function of material and/or part wholesale to the businesses, since SME cannot purchase large lot of products (materials or parts) to complete their productions and they do not have capacity to hold large storage for large quantity of material stock. Therefore, vocational schools can be wholesale market among multiple production businesses. Possible locations of vocational school developments are:

  - A site nearby Tidal Basin North Development: Multi-sector production and logistics related
  - A site nearby or within Malahang Industrial Park: Food processing related

- A site within Kamkumun Industrial Area: Metal work and vehicle repair related
- A site within Yalu Industrial Park: Wood products and furniture related
- A site nearby Bubia Industrial Park: Agriculture production related

➢ Technical Colleges

Higher education in technical fields is also important for the Lae-Nadzab Area development considering better economic activities enhanced with technical upgrades on both facilities and engineers. While vocational schools will be gradually training local people in various field of industry and these skills, technical schools in the area will pursue higher level of technological skills and knowledge input to not only working people or engineers but also companies and their facilities through possible technical support and programs. The technical collage development is considered under the Master Plan from industrial development point of view in Nadzab area and Igam area where cooperative education with UNITC may be easily accomplished.

• Nadzab Airport City Development and Technical Collage

The Science City concept is set for effective development of Nadzab Airport City with the airport upgrade under the JICA financial assistance. Nadzab Airport City development is one of the Master Plan targets and this area will start gradual change after the upgraded airport facility opening. The Science City development concept is set for suitable approach to draw attention of market, businesses and people to come into this place. Since the population and economic activities in the area will be very limited at the earlier stage, technical college development with the State Government supported education programs in engineering, medical and science fields should be developed with supportive business and service activities in the area. Students will settle and gradual expansion of various activities will start. The college program will extend its network with actual industrial and other market needs including higher needs of rural area medical support even targeting Highlands region. The Education and actual technical training will be reflected back to the real industrial activities and production technologies in the future.

• Technical College Development with UNITEC Program Corporation

This college development will focus on the engineering oriented technical program together with existing UNITEC program. Because of its proximity to Lae Urban Area and those industrial centres either existing or will be developed, targeted engineering program of the college should have more clear focus in relation with these considered industrial fields and activities.

(2) Healthcare Facilities

According to the hearings from existing healthcare services and workers in the region, most of the facilities must cover too large catchment area more than their capacity can possibly handle, and the radius of service (in other words, patients' walking or access distance) is too long as well as some are over 10 miles without ambulance service. Based on the population growth estimation under the Project development, the population in the Project Area will be 275,000 at the time of year 2025 which is 1.45 times of the 2011 population. The regional healthcare service should be well developed with effective improvement to handle such population increase.

Currently many clinics or health centres in the Project Area has very large catchment population against actual capacity and service level, and many aid posts also face very large catchment population. Japanese development standard for healthcare facility recommends one hospital for 4,000 or more households and one local clinic for 500 to 1,000 households. Comparing with this figure, many aid posts as well as clinics and health centres in the region today are responsible for far beyond of acceptable population. Therefore, these heavily loaded population ratios of each facility should be reduced for easier and more quality services, and more localized aid posts, for instance, should be developed in the next ten years as the region expects rapid population growth due to industrial development. The following tables illustrate healthcare facilities with required immediate service improvement.

Table 12.11.7 List of Healthcare Facility Development in each Ward

LLG Name	Ward No.	Ward Name	Future Population		Facility Condition	Facility Development
			2025	Ward Total		
Lae Urban (LU)	1	ERIKU/BUNDI	3,407	30,466	with Kamkumun AP and Buimo CIS AP	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	846			
	1	ERIKU/BUNDI	2,809			
	1	ERIKU/BUNDI	2,010			
	1	ERIKU/BUNDI	16,434			
	1	ERIKU/BUNDI	4,961			
	2	TOP TOWN	2,135	12,922	with Angau Hospital and Haikost UC	1. Angau Hospital to be upgraded by Australian Aid 2. Service improvement of Haikost UC
	2	TOP TOWN	818			
	2	TOP TOWN	8,967			
	2	TOP TOWN	1,002			
	3	MAIN MARKET	991	12,693	with Milfordhaven UC	1. Upgrade of Milfordhaven UC to CHP 2. One (1) new aid post setup
	3	MAIN MARKET	2,229			
	3	MAIN MARKET	905			
	3	MAIN MARKET	8,568			
	4	HAIKOST	10,911	13,922	with Buimo UC	1. Upgrade of Buimo UC to CHP 2. One (1) new aid post setup
	4	HAIKOST	3,011			
	5	UNITECH	3,778	16,455	with UNITEC UC and Tent City UC	1. Upgrade of UNITEC UC to CHP 2. Upgrade of Tent City UC to CHP
	5	UNITECH	12,677			
	6A	EAST TARAKA	4,750	4,750	with Buimo CIS	1. Share Buimo CIS CHP
	6B	WEST TARAKA	7,544	7,544	with Tarak UC	1. Upgrade of Taraka UC to CHP
	6C	IGAM	4,251	4,251	with Igam UC	1. Service improvement of Igam UC
Ahi (A) Ahi (A)	1	HENGALI	4,540	4,540	with Butimum UC	1. Service improvement of Butimum UC
	2	BUTIBAM WEST	2,283	2,283	New	1. One (1) new aid post setup
	3	BUTIBAM EAST	1,862	1,862	with Ampo AP	1. Service improvement of Ampo AP
	4	WEST BUKO	669	669	New	1. Share East Buko Aid Post
	5	EAST BUKO	1,341	1,341	New	1. One (1) new aid post setup
	6	WEST WAGANG	No Increase	N/A	N/A	N/A
	7	EAST WAGANG	4,378	4,378	New	1. One (1) new aid post setup
	8	YANGA	1,883	7,254	New	1. New setup of one (1) CHP
	8	YANGA	5,371			
	9	GAWANG	5,820	5,820	New	1. One (1) new aid post setup
	10	BUSURUM	1,359	1,359	New	1. One (1) new aid post setup
	11	MALAHANG	574	574	with Halahang HC	1. Service and facility improvement of Halahang HC
	12	BUSU-POASANG	4,948	4,948	New	1. One (1) new aid post setup
	13	POAHOM	9,000	9,000	New	1. New setup of one (1) CHP
	14	LIMKI	14,326	14,326	New	1. New setup of one (1) CHP
	15	KAMKUMUNG	2,884	2,884	with Kamkumum AP	1. Share Kamkumum CHP
	16	POASUM	18,762	18,762	New	1. New setup of one (1) CHP 2. Share Malahang HC
	17	BUMAYONG	4,911	10,000	with Bumayong AP	1. New setup of one (1) CHP
	17	BUMAYONG	2,383			
	17	BUMAYONG	2,383			
	17	BUMAYONG	323			
Labuta (L)	12	MUSOM/TALE	2,237	2,237	New	1. One (1) new aid post setup

LLG Name	Ward No.	Ward Name	Future Population		Facility Condition	Facility Development
			2025	Ward Total		
	13	SITUM	6,597	6,597	Existing SITUM Health Sub-centre	1. Upgrade of SITUM HC to CHP
Nabak (N)	13	HOBU	1,167	1,167	New	1. One (1) new aid post setup
Wampar (W)	3	GABENSIS	1,937	1,937	with Gabensis AP	1. Service improvement of Gabensis AP
	4	UMSIS	1,223	1,223	New	1. One (1) new aid post setup
	5	MARKHAM BRIDGE	1,840	1,840	with Markham Bridge AP	1.Service Improvement of Markham Bridge AP
	6	LABUTALE	No Increase	N/A	New	1. One (1) new aid post setup
	7	LABUMITI	1,266	1,266	with Labumiti	1. Service improvement of Labumiti AP
	8	LABUBUTU	1,734	1,734	with Labbutu	1. Service improvement of Labubutu AP
	9	GAWANG/5 MILE	10,911	10,911	with 6-Mile AP	1. Upgrade of 6-Mile AP to CHP
	10	ST JOSEPH	10,292	10,292	New	1. New setup of one (1) CHP
	11	AWILLUNGA	11,058	11,058	New	1. New setup of one (1) CHP
	12	BUBIA	6,773	6,773	with Bubia AP	1. Service improvement of Bubia AP
	13	BUSANIM	5,961	5,961	New	1. One (1) new aid post setup
	14	YALU	4,695	4,695	with Muya AP	1. Service improvement of Muya AP
	15	MUNUM	2,823	2,823	New	1. One (1) new aid post setup
	16	NASUAPUM	1,482	1,482	with Nasuapum AP	1. Service improvement of Nasuapum AP
	17	GAPSONGKEG	8,290	8,290	with Wampar HC and Gabsongkek AP	1. Upgrade of Wampar HC facility and service with CHP function 1. Service improvement of Gabsongkek AP
	18	NAROMANGKI	1,710	1,710	with Erap Station AP	1. Service improvement of Erap Station AP

Source: JICA Project Team

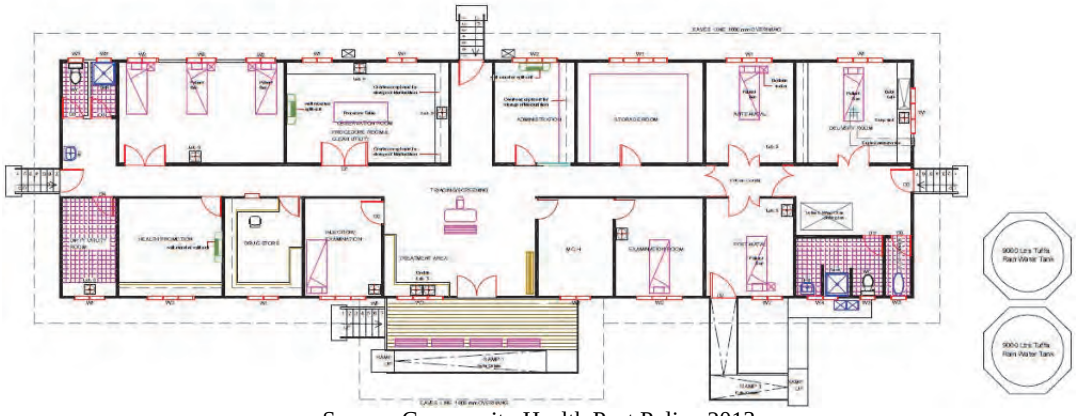
Under the PNG Community Health Post Policy 2013 (CHP Policy), a new concept and development can be brought to the community level healthcare system. This will remodel existing aid post or sub-health centre, and provide more immediate service within the geographical boundary with at least three health workers providing wider range of primary healthcare, such as child and maternal health services, midwifery, immunization, family planning, health promotion and community awareness and emergency care and stabilization of patients which can be provided prior to a referral to a health centre or hospital. The facility and services is considered as 24-hour emergency services at Level-2 operation. Delivery facility and waiting rooms for expected mothers are part of the services, and healthcare workers' quarters should also be included for on-site and immediate services. Considering Japanese development standard, those facilities with catchment population over 6,000[6] should be upgraded to the Community Health Post (CHP) to serve over 10,000 population area, and other aid posts should have service improved.

This new community healthcare service concept "CHP" has not been implemented in the Project Area, however this system focuses on more localized primary referral to provide minimum but immediate care so that this facility development is more effective for the next ten years. Allocation of number of healthcare workers in each station may be an issue for operation and cost. CHP policy indicates three major aspects for strategic location selection: Health Needs, Accessibility, and Community Structure & Needs. However the setup strategy of the location for CHP development is not specific, therefore the above highlighted facilities with catchment population over 6,000 will be upgraded with CHP for better services, unless otherwise the Provincial Administration sets particular rules.

When CHPs are established within the growing centres of the region, each CHP should act as the

[6] CHP is larger than typically planned local clinic and catchment household may be considered at scale of 1,000 for the development, and each household is considered with 5 to 6 family members (National Census Data)

service operation centre which controls other aid posts in the same development area, while CHP also acts as networking centre among other CHPs in the Project Area. The figure illustrates typical CHP facility plan shown in CHP Policy 2013 by National Department of Health.



Source: Community Health Post Policy 2013
Figure 12.11.1 CHP Typical Facility Floor Plan

On the other hand, urban clinics (UC) and health centres (HC) are at more serious situation with quite large number of catchment population. However, the magnitude of their services, especially of clinics, is much higher than the possible service level of CHP. Therefore, one (1) CHP facility[7] will be proposed for catchment area with over 10,000 population, and the existing facilities of UC or HC will be upgraded or service improved including the service level and function of CHP.

Future development of healthcare facility in the region beyond 2025 will be executed by the local government agency, according to the social survey and population analysis to be conducted in the future. Same as school facility development, social condition and population survey by MPA should be conducted in every five-year period as recommended, so that detailed development plan with budget allocation can be revised for the best effective service delivery. Thus, healthcare facility will be gradually provided beyond 2025 in line with population increase in each Ward.

(3) Public Parks and Other Parks

Public park development is a part of "Garden City" realization process under the development Master Plan. There are many urban and/or rural activity centres or nodes within the Project Area, and they will be developed or improved with necessary functions. These development elements, centres, nodes or even just buildings shall be all connected as parts of green network structure to achieve the concept. To achieve green network development under the Garden City concept, there are several green landscaping plans to be implemented.

- Green landscaping for public parks and public facilities
- Street and Road side green landscaping for linier connection between places
- Developing more public parks and gardens for people's use in all over the Master Plan target area
- Green industrial park/zone development for more environmental friendly production sites
- Green landscaping for buffering issues such as noise and odour between different zoning areas

j) Public Parks

Current development of public parks in the Project Area indicates that rural areas have not been well treated or provided with public recreational facilities, such as parks and sports fields comparing to the number of parks or public spaces developed in Lae Urban Area. As described in the earlier Section of 6.10, many of these public spaces in Lae are not effectively utilized for local people.

[7] According to the Department of Health, PNG, construction cost of a basic package of Three (3) Men CHP with three (3) quarters is estimated 3 million PGK for full operation. Construction cost for one (1) aid post is estimated at 300,000 PGK, and facility improvement cost for one aid post is estimated 100,000 PGK.

There are several sports parks developed as shown in the earlier Section 6.10 along the major road networks, however these are not benefitting for all local people because of limited accessibility under insufficient of public transportation or of long distance. In this regard, more local community oriented parks should be provided for immediate use by community residents. The following types of public parks[8] could be considered for selection and development for the Project target year 2025.

Neighbourhood Park	Approx. 2 hectares of open park will be provided for about 500 metres distance in the neighbourhood.
District Park[9]	Approx. 4 hectares of open park will be provided for about 1km walking distance for community residents.
Regional Comprehensive Park	Urban park with 10 to 50 hectares space in one city will be provided for all city residents' use of recreation, walking, play, sports activities, etc.
Sports Park	Sports activity oriented park with 15 to 75 hectares space in one city will be provided for all city residents' use.
Regional Park	Large park over 50 hectares will be provided considering a region larger than one city or town unit for multiple recreational activity purposes.

The population growth expected in the Project target area described in the population frame Section in 2025 is 275,000, and 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 development under the national development plan such large scale park development may be necessary to serve local communities in Lae-Nadzab Area. Rural areas, instead of Lae City area especially, will be still less populated in 2025, and the large park development could be unnecessary for large investment. The sports parks along the Highlands Highway and in Lae City area should serve local communities enough with better public park utilization program and regulation.

Accordingly, 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 above described "district parks[10]" for local communities.

The size of park space could be smaller than the described figure above. Instead of one kilometre of distance, the parks will be located at average of two kilometres distance, and the development can be skipped where any public park(s) is already developed along major roads in rural areas. Where a village is remotely located from other populated areas with 500 to 1,000 households, such village(s) should be also provided with a public park but the size could be smaller for relatively smaller community use. Such "parks (possibly neighbourhood parks)" could be equipped with smaller open field for any activities, children's park facility with comfortable landscape and resting facilities.


Children's Play Facility


Green Park


Resting Facility

Source: Google

Figure 12.11.2 Typical Neighbourhood Park and District Park Images (Samples in Japan)

k) Industrial Park Development

According to the industrial development plan described in Chapter-11, the Master Plan consists of several industrial parks and production centre/area developments. Type of business, type of

[8] Typical types of public parks described under the Japanese urban park development in Urban Parks Act.

[9] Definition of "district" is not the term used in PNG to define the governing administrative boundary of group of wards, and "district" means localized area that is in walkable distance or comfortable area of the same community.

[10] Estimated construction cost for one (1) park (district park level) at 2 to 3 ha of area is 150,000 PGK based on the typical cost in Japanese market with a few benches, gate structure, flower garden, and others set with flat land (no level control necessary).

products, size and area are all different, however there should be green development together with those industrial developments necessary. When any new development of industrial park(s) or expansion of the existing industrial area(s) takes place, the following green development should be made together in order to contribute the "Garden City" development.

- Industrial park/zone inner road green landscaping

  Where it is possible to plant trees along internal road sidewalks and medians to make the industrial park/zone more liveable with natural elements. Wider roads, if developed, should be planted with good sized trees for shading contribution.

- Industrial park/zone perimeter buffer green landscaping

  Some industrial parks/zones may distribute noise or odour to the surrounding areas because of their production, and these sometimes are not comfortable to nearby residents. Therefore, perimeter zone with minimum 5 metres width or appropriate wider should be well tree and hedge planted to make noise and odour buffer zone against neighbouring areas. The buffer zone width may be carefully studied based on the levels of noise and/or odour to minimize any negative impacts on and grievances from neighbours.

- Up to 15%[11] of an industrial park/zone development area green landscaping

  Industrial parks/zones should also be landscaped with good enough amount of greens (trees, lawns, hedges and others) to maintain both visual and environmental comfort not only for workers but also for people around. Therefore, 10% of total development area of each industrial park/zone shall be used for green landscaping, and 15% of the area is recommended for better environment.

l) Other Special Parks in the Project Area

Other than commonly developed and used by local people, there should be several special parks to be developed, although general community level amenity set up should come first so that those special parks may be the secondary targets under the Master Plan. The following parks and facilities are considered for the mid-to-long term stage development utilizing existing local resources and/or opportunities to enhance recreational activities.

- Coastal Park

  There are preserved natural resources in both gulf and surrounding land along the Huon Gulf coast line including Labu Area. Such natural resources should be highly beneficial to the Lae-Nadzab Area community if these are utilized for recreational purposes for both local people and people from outside. Because of such potential, the Huon Gulf coastal area should be developed as linier recreational park considering major tourism activities. Expected jetty development along Labu village areas will contribute more accessible recreational services together with upgrading local water taxi services and yacht harbour facility utilization to attract wider range of users. Marine sport facilities as well as common sport facilities along the bay area will function as integrated activity network system.

- Existing Botanical Garden Extended Utilization

  Currently existing Botanical Garden in Lae City is not fully open to the public use as it is meant for research purposes. While keeping its function as research facility for educational purposes, opening up to the local community should deliver more opportunities to the people in Lae-Nadzab Area. This facility, if opened to public, should become a part of recreational service network with other local public parks, service facilities and recreational centres, which will be developed in the future stage. Easier access to the people also provides general educational opportunities to those people to learn about local flora and fauna as well as ecosystem so that developing environmental friendly mind among local people will be achieved.

- Wanum Lake Park

[11] It is recommended over 10% up to 20% of total area should be green landscaped under the Japanese regulations.

The lake Wanum is a hardly touched natural lake located between Nadzab and Gabensis. Surrounding natural condition is ideal to develop a nature oriented experiencing park together with surrounding mountain landscape. The level of development should be carefully controlled, but accessibility and common tourism services need to be well prepared for multilevel tourists including foreigners when it is developed in the future stage. The recreational function should be a part of the regional network integrated with coastal parks, mountain parks and other facilities including other regions considering traditional and cultural elements and values.

- Labu Lagoon Seaside Park

There is a large lagoon in Labu area south of Labu Situ and its area is quite large having healthy preserved natural condition. This lagoon should be a great development resource and opportunity to make the Labu area into a tourism oriented place with communities' closer involvement. Development process should require number of steps so that the actual park development will take place in later stage of the Master Plan development. When the lagoon park is completed, this will function not only as the tourist attraction base but also fishery farm. Some parts of the lagoon will be utilized for farming purposes while selected areas will be developed for tourist destination integrating other Labu area resources in connection with the coastal park development. The development program may consider community based tourism to support local Labu people who have been struggling with reducing amount of fish catches. Such tourism development should be well integrated with existing local tradition and culture.

- Sports Facilities

Since Lae-Nadzab Area is in need of basic social service facilities today, such as community park and neighbourhood park type developments, sports facilities may be considered for later stage development. However, there are some existing facilities in the Project Area, such as Sir Ignatius Kilage Sports Facility and Lae Golf Course, and upgrading or some expansion of these facilities may be effective to draw regional attention for more use. As for the long term development target, selected development centres in Nadzab, Yalu and Lae Urban Areas should be equipped with larger sports facilities looking at increased population in the future.

(4) Community Centres

The existing community centres or similar facilities in the region in general are not at the quality in terms of sizes and functions for necessary community services except a few facilities. As described in earlier section, some communities only have a container type building that could be used only for storage or temporary office use and a very small covered gathering space which could only hold about 30 to 50 people while the catchment area is highly populated. Many communities and villages have put their own effort and funding in order to construct their community centre and/or gathering structure, however maintenance cost cannot be easily borne by the community.

Each Ward unit is the priority to provide efficient community centre and facility in order to centralize Ward level communication and activities among neighbouring villages and communities. The centre should consist of administrative office for Ward level official work by selected members and Ward administrator, common community gathering for about 100 people, community toilet, storage for Ward level administrative data and information, and ancillary room for proper functioning. This packaged facility[12] should be provided with larger open space for other outdoor community activities that could also function as emergency gathering space under disaster situation and others, thus 2 to 3 hectares of development land for community centre for each Ward will be necessary where no efficient facility is provided.

Maximum 5,000 local population for a centre could possibly provide proper community function and services, however some centres may need to serve much larger community because of population concentration. Such centres may be at larger size to deliver effective and sufficient services to the communities.

[12] Except the land acquisition cost, above mentioned facility package may possibly cost about 500,000 to 750,000 PGK, however it should be based on the actual size of buildings for each community.

When actual local community centre development plans are detailed, each Ward level local issues must be identified including locally existing tradition, culture and living condition to reflect over the facility function. Based on the community's traditional or cultural aspect and customs, there should be some specific requirement should be well incorporated into the function and design, such as ways of gathering or special activity use, etc.

(5) Police Stations

Current PNG living environment is under major threat of criminal activities as crime commitment is increasing and occurring daily basis all over the country. However, the number of police stations and police officers allocated are not sufficient to protect citizens from such unwanted activities and incidents. Increasing protection and safety level of the society is so important to achieve successful industrial and economic development in Lae-Nadzab Area as well as in the country. Therefore, the new development Master Plan of the Project shall also illustrate guidance to improve the social security and safety control with additional police station development in the Project Area. There are only a small number of police stations set for services, and the magnitude of the development of facility and services should be at much higher level for the Lae-Nadzab Area security and safety control.

Lae-Nadzab Area is considered by PNG central government as of the country's industrial and distribution centre in the future, and the security control and safety management by daily basis police service enforcement is mandatory for healthy and strong economic development in the region. Thus, upgrade security service quality as well as expand police service in the Project Area is necessary.

There is no internationally proved and accepted standard or guideline to set up police station in community, because each community and/or urban setting (or even rural setting) has unique condition due to culture, population, street and building arrangement, geographical setting, etc. Therefore, the set up basis is introduced for the new LNUDP for initial development evaluation in cost and schedule. One police station[13] will be developed within 10 square kilometres catchment area or for one community with population of 1,000 in rural areas. Each police station should be set with minimum three police officers to effective patrol for the community. Where larger population is concentrated such as Lae Urban Area, more number of officers should be allocated with double sized police station structure. When actual implementation takes place, detailed study of service setup should be made in accordance with all norms and regulations of the police authority.

12.11.3 Social Service Project Summary

The following table summarizes the social service development projects in the Project Area under the Master Plan development. The target year is set within the next ten years to improve general social services, and the additional services and facilities will be developed afterward for more recreational environmental improvement in the Project Area.

Table 12.11.8 Social Service Improvement Project List

No	Project Title	Project Outline	Proposed Location
SS-1	Facility Capacity and Accessibility improvement for the Primary Schools in the Project Area	Existing primary schools are currently facing major problem of classroom shortages in all LLGs in the Project Area, and school aged children are having difficulties to attend schools due to long distance as well as due to their family economic issues. Thus, increasing capacity of each school to meet demand according to Ward level population and and reduce walking distance according to the populated location to suite school sites are mandatory to improve educational environment for all school aged children.	Overall Project Area in each Ward in the Project target Districts

[13] Construction cost for one (1) typical police station is estimated at 350,000 PGK based on other typical small-scale building construction cost, such as teachers' quarters.

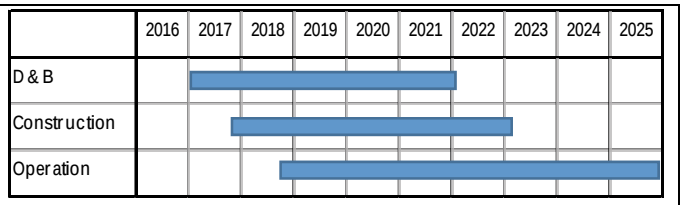
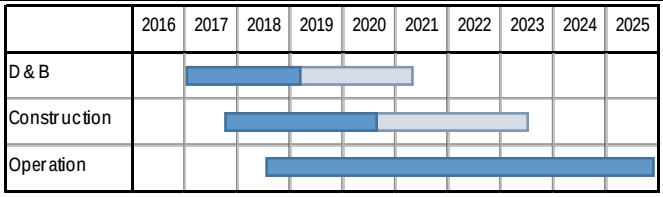
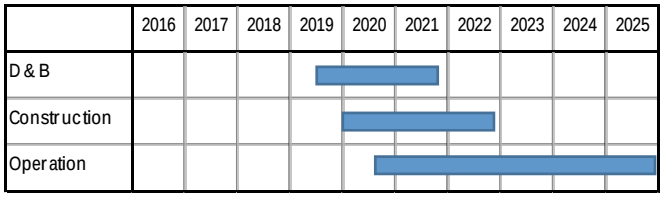
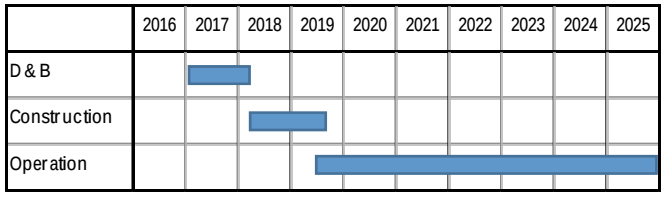
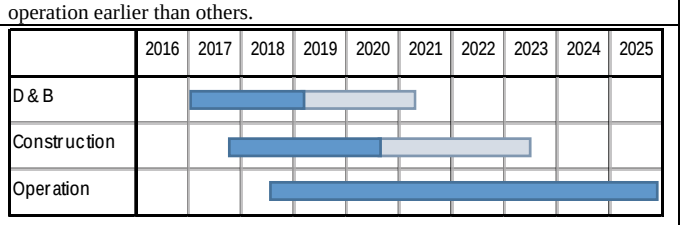
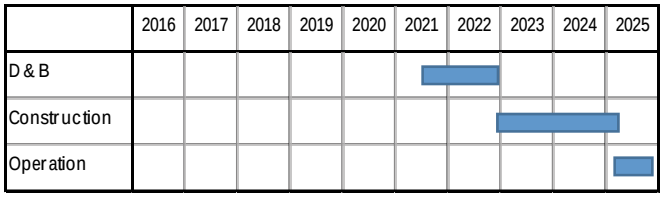
No	Project Title	Project Outline	Proposed Location
SS-2	Capacity and Service Quality improvement for the Healthcare Facilities in the Project Area	Existing healthcare facilities including aid posts and Urban Clinics are currently facing major problems of facility capacity, catchment area management, shortage of health workers and nursing officers to provide adequate healthcare services. Thus, increasing capacity and service level of each healthcare facility to meet demand according to Ward level population is mandatory to improve service quality and secure health level of local population.	Overall Project Area in each Ward in the Project target Districts
SS-3	Public Park and Amenity Facility development in the Project Area	Current urban and public amenity setup is only concentrating in Lae City area and areas along major trunk roads, and each community or villages (smaller than Ward level) and these people do not have benefit of public amenities. Thus, developing public amenity, facilities and parks to meet demand of recreational activities among local people is mandatory to improve livelihood and living environment.	Over all Project Area, and remotely located villages and small communities to be priority targets
SS-4	Ward Level Community Centre development in the Project Area	There are very limited community gathering and function facilities in the Project Area, and developing Ward level Community Centres to meet demand of information sharing and gathering among local people is mandatory to improve communication among local population.	Each Ward in the Project Area
SS-5	Police Station development in the Project Area	The Project Area is currently covered by very limited and small number of police stations and services with also very limited number of police officials. Besides, the crime commitment is increasing in all over the PNG region. Thus, increasing capacity and service level of police facility and officials to meet demand according to Ward level population is mandatory to improve security level of local population.	All Project Area, especially where more increase of population is expected and where communities are so isolated or remote from urban areas
SS-6	Sports Facility development in Lae Urban Area	As Lae-Nadzab Area will grow as the national centre of industry and distribution, existing sports centre should be fully equipped for international level sports activities. Expanding and improving the sports facility in Lae to meet demands of not only regional but also national level sports activities is mandatory to add more attractiveness of the Lae-Nadzab Area for the nationwide needs. This is Lae City Administration projected development Plan incorporated in the new Master Plan.	Lae City: The Location at the existing Sir Ignatius Kilage Sports Facility

Source: JICA Project Team

Project development costs and implementation schedules are illustrated in the following table. Above listed projects are the fundamental social service improvements so that these are considered within the Project period of ten years based on the population increase. Although the schedule is set, the development plan shall be reviewed periodically based on the monitoring results in order to adjust the plans.

Table 12.11.9 Social Service Improvement Project Cost and Implementation Schedule

No	Project Title	Project Cost	Implementation Schedule
SS-1	Facility Capacity and Accessibility improvement for the Primary Schools in the Project Area	801 Mil. PGK	Note: Small development may take shorter period for design, bidding and construction. Where later construction of school facilities are only required based on the detailed student population survey, the

			 implementation schedule will start at later stage of the Project year.
SS-2	Capacity and Service Quality improvement for the Healthcare Facilities in the Project Area	84 Mil. PGK	 Note: Service improvement and aid post development for urgent site may take earlier period for D&B and construction. Where later construction of facilities is only required based on the detailed survey, the implementation schedule will start at later stage of the Project year. CHP development in more populated areas should be implemented at earlier stage.
SS-3	Public Park and Amenity Facility development in the Project Area	23 Mil. PGK	 Note: Public parks and amenity facilities will be developed during the middle of the Project target period after other necessary social service developments are made for general service improvement.
SS-4	Ward Level Community Centre development in the Project Area	48 Mil. PGK	 Note: Wards which do not have proper government provided community centre should be prioritized for development. Some centres may start operation earlier than others.
SS-5	Police Station development in the Project Area	53 Mil. PGK	 Note: Police station development for urgent sites may take place in earlier period for design, bidding and construction based on the design guidelines and regulations.
SS-6	Sports Facility development in Lae Urban Area	40 Mil. PGK (estimated by LULLG)	 Note: Upgrade of the existing facility is targeted, and existing parts will be operated during new construction of additional facilities.

Source: JICA Project Team
Note: D&B refers to Design and Bidding Stage

12.12 Others

There are several possibilities to develop other service facilities for tourism activities, for instance. Today there are existing tourism activities such as live exhibition of traditional villages and cultural dances in remote areas in PNG, however those are not easily accessible by today's transportation network. For the development during the next ten years with the Project may focus on the infrastructure development in the Project Area to improve wider accessibility. Meanwhile, more PNG local tourists may be expected for visiting regional tourism sites for joy. For inviting foreign tourists to such activities need to take more preparation for services such as high quality accommodation, reliable transportation system and network, safety and security and quality food and sanitary hygiene control, as such. In order to develop such level of service infrastructure, the Project aims to spend next ten years for basic service infrastructure to be developed so that such infrastructure will be the true basis for the high level service infrastructure installation for quality tourism inviting foreign guests to the region.

Besides, there are several possible tourism development sites under the Project considered for the future development.

- 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.

Possible site candidate may be selected in Labu Coastal area and Wanum Lake area and those surrounding areas for above noted future development of tourism.

Development of tourism infrastructure should take some time because of several levels of improvement in various services being necessary, such as site access infrastructure including transportation development, accommodation development, service quality improvement in bedding, quality and safe food supply and information supply, activity program development, and others. Before actual implementation of tourism destinations and their facilities development, the following actions and infrastructure preparations (not limited) should be made, especially to the Labu Coastal area and Wanum Lake area.

- Existing natural conditions, including water quality, ecosystem, geological conditions, etc., should be examined to identify best effective and environmentally friendly development plan for those target sites.
- Overall regional transportation network including the airport service should be upgraded and improved for more effective access to the integrated regional recreational service network.
- Together with transportation infrastructure development, jetty(s) and water taxi or water transportation systems should be prepared for easy access to Labu area.
- The road network to Wanum Lake should be upgraded for better accessibility.
- Stable and reliable water and power supply should be installed.
- As for better tourism program operation and related facility maintenance, local community based O&M bodies for each tourism site should be established.
- To properly protect nature and natural condition and manage environmental control, park user guide and manuals as well as environmental control regulations should be well prepared.
- Service facilities, such as day trip based restaurants, toilet facilities, rest areas, information station, should be developed for the day trip program establishment as an earlier development program.

CHAPTER 13 MASTER PLAN INVESTMENT COST AND FINANCE

13.1 Cost Estimate

In estimating the Project costs of the Master Plan, 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 Japan for bridge structures because of no availability of such data.

Table 13.1.1 Project Cost Component

No	Item	Rate	Calculating 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 Study Team

13.2 Source of Fund

This chapter studies; firstly, the financial capability of the governments for the Master Plan based on their budgets; secondly, the expected financial sources to fill the gap between the capability and the investment costs of the Master Plan.

(1) Budget of Central and Local Governments

Year budgets of the governments are presented below respectively.

1) Central Government

Table 13.2.1 shows he budget of the Central Government of the financial years from 2013 to 2015. The government budgeted PGK 4,270 million for the capital expenditures in 2015, which is equivalent to 17% of the overall expenditure budget.

Table 13.2.1 Budget of Central Government (PGK million)

Budget Items		2013	2014	2015	
		Actual	Revised	Budget	%
Revenues	Tax	8,599	9,744	11,257	57
	Non-tax	192	1,229	1,066	5
	Grants	611	1,684	1,384	7
	Borrowings	6,915	7,892	6,289	31
	Total	16,317	20,549	19,996	100
Expenditures	Personnel	3,099	3,093	3,841	15
	Other recurrent	5,748	7,238	6,960	28
	Capital	908	2,157	4,270	17
	Repayment	4,792	6,288	9,924	40
	Total	14,547	18,776	24,994	100
Year Balance		1,770	1,773	-4,998	

Source: Budget book of the Central Government

Table 13.2.2 gives the distribution to the departments, the agencies and the provinces out of the

above capital expenditures. The coloured spaces indicate the sectors related to the Master Plan and the allocated amount respectively. Meanwhile, around 30% of total capital expenditures PGK 4,270 million is to be funded by the international donors; on the other hand, around 60% is to be granted to the related sectors' capital expenses（Public Investment Program 2016-2010）.

Table 13.2.2 Distribution of Expenditure Budget (PGK million)

Distribution to:		2013	2014	2015			
		Actual	Revised	Budget	(%)	Capital [1)]	(%)
National Departments (31) and Offices (38)	Agriculture & Livestock	23	43	73	0.3	20	0.5
	Lands & Physical Planning	60	62	59	0.2	14	0.3
	Transport	19	23	35	0.1	7	0.2
	Commerce & Industry	30	75	69	0.3	34	0.8
	Industrial Relations	16	27	35	0.1	2	0.1
	Works & Implementation	555	929	1,511	6.0	1,131	26.5
	Education	941	953	1,141	4.6	40	0.9
	Higher Education	71	78	283	1.1	119	2.8
	Health	423	752	614	2.5	19	0.5
	Other 60	5,311	6,833	6,444	25.8	1,178	27.6
	Debt Service Charges	4,792	6,288	9,924	39.7	-	-
	Total	10,806	14,280	20,188	80.8	2,545	59.6
Statutory Authorities (68)	Investment Promotion A.	3	3	4	0.0	-	0.0
	Small Business Dev. Corp.	3	3	4	0.0	0	0.0
	Industrial Centres Dev. Corp.	2	2	3	0.0	0	0.0
	Coastal Fisheries Dev. A.	21	42	28	0.1	18	0.4
	Cocoa Coconut Inst.	7	7	8	0.0	0	0.0
	PNG National Fisheries A.	0	0	20	0.1	10	0.2
	Fresh Produce Dev. Comp.	6	6	12	0.0	0	0.0
	PNG Coffee Ind. Corp.	3	5	3	0.0	0	0.0
	PNG Oil Palm Ind. Corp.	27	10	0	0.0	0	0.0
	PNG Power Ltd.	7	19	117	0.5	89	2.1
	Other 58 Authorities	619	1,087	947	3.8	409	9.6
	Total	690	1,165	1,146	4.6	527	12.3
Provincial Government Grants (22)	Morobe Prov. Gov.	266	264	327	1.3	123	2.9
	Other 21 governments	2,785	3,066	3,334	13.3	1,076	25.2
	Total	3,051	3,330	3,661	14.6	1,199	28.1

Note: 1) Capital budget is included in the overall 2015 budget.
Source: Budget book of the Central Government

2) Provincial Government

Table 13.2.3 presents the budget of Morobe Provincial Government. The hatched columns are considered as the capital expenditure budget of the government totalling up to PGK 176 million. This figure may include the distributed capital budget of PGK 123 million from the central government; so that the capital budget from the own source of the provincial government is estimated at PGK 53 million in 2015 financial year.

Table 13.2.3 Budget of Morobe Provincial Government (in PGK million)

Budget Items		2013	2014	2015		2016 [1)]	
		Actual	Actual	Budget	%	Budget	%
Revenues	Tax	79	84	97	20	91	20
	Non-tax			22	5	21	5
	Grants	70	263	362	75	350	76
	Total	149	347	481	100	462	100
Expenditures	Personnel	18	93	179	37	180	39
	Other recurrent	63	60	79	16	89	19
	Grant to LLG	2	24	10	2	10	2
	Transport Infra. Mainte. Grant	1	2	2	0	2	0

Budget Items		2013	2014	2015		2016 [1)]	
		Actual	Actual	Budget	%	Budget	%
	District Services Improvement	2	90	90	19	90	20
	Province. Services Improvement	32	45	45	9	10	2
	Development	26	33	41	8	29	6
	Former years' appropriation	4	0	35	7	51	11
	Total	149	347	481	100	462	100

Note: 1) 2016 budget is before approval of the council.
Source: Budget book of Morobe Provincial Government

3) Local Government

Table 13.2.4 gives the budget of the district and the local level governments. The capital expenditures are to be allocated form the own sources; however, the size of capital budget is quite small.

Table 13.2.4 2015 Budget of Local Governments (in PGK million)

Budget Items		District G.	Local Level Government		
		Lae	Lae Urban	Ahi Rural	Wampar
Revenues	Recurrent	Not available	14.8	0.06	0.04
	Grant		2.6	1.3	1.1
	Total		17.4	1.4	1.1
Expenditures	Personnel	0.8	8.5	1.4	1.1
	Other Recurrent	5.4	4.7		
	Capital	8.3	4.2		
Total		14.5	17.4	1.4	1.1

Source: Budget book of each government

(2) Financial Capability for Master Plan Project Costs

The capability of the governments to bear the master projects costs is analysed and estimated as follows.

1) Premises for the estimate

- To be estimated based on the capital expenditure budgets of FY 2015
- The Central Government will be a main funding player; the provincial and local governments are not capable because of their small size budgets.
- The capital budget will be distributed to the Master Plan projects with a high priority as national projects because the Master Plan aims to develop the region of national and economical importance.
- The capital budget distribution to the Master Plan projects is estimated as follows.
  - i) Central Government
    - Minimum 1% up to maximum 5% of the related sectors' budget as presented in Table 13.2.2, such sectors as Works & Implementation、Education、Higher Education and Health
    - Minimum 15% up to maximum 20% of the allocated budget to Morobe Provincial Government
  - ii) Morobe Provincial Government
    5% of the capital budget funded from own sources
  - iii) Local Governments
    10% of the capital budgets

2) Financial Capability

Based on the above premises, the financial capability of the PNG side is summarized as presented in Table 13.2.5. In year average, around PGK 20 million up to PGK 75 million could be funded for the Master Plan accordingly; and totalling up to from PGK160 million to PGK 600 million over the period of 8 years until the Master Plan target year of 2025.

Table 13.2.5 Summary of Estimated Funding Capability

Governments	Sources: Capital Expenditures Budget (PGK million)		Distribution to Master Plan	Funding Capability (PGK million)
Central	Total of Works & Implementation、Education、Higher Education and Health	1,309	1%～5%	13.1～65.5
	Distributed to Morobe Provincial Government	123	1%～5%	1.2～6.2
Provincial	Out of own sources	53	5%	2.6
Local	Out of own sources	12	10%	1.2
Year Total				**Around 20～75**
Total of 8 years (2018-2015)				Around 160～600

Source: Estimate by JICA Expert Team

(3) Funding to fill the Gap

It is likely that overall investment costs of the Master Plan exceed the financial capability of the PNG government side. To fulfil the whole implementation of the Master Plan, the other sources of fund should be procured furthermore for filling up the gap; for this, the following steps are suggested to be taken.

- Request of financial assistance to donors; especially for road construction, flood mitigation/control, and social sectors such as education and health
- Inducing the private sector participation; particularly in development of residential areas and industrial park
- Government guarantees to the revenue generating project for bank loan and bond issue; especially for water supply and sewerage system
- Creation of special subsidies for environmental protection; especially for solid waste management

CHAPTER 14 SOCIAL ENVIRONMENTAL ASSESSEMENT

This Chapter outlines the social-environmental aspects of the Project area focusing on the policy and legislative requirement, including that of the international obligations and requirements pertinent to such Project design and development.

The purpose of this Chapter is to provide information on the relevant policy and legislative requirements of both PNG and the international institutions such as JICA, as a reference and guidance to internationally accepted best practices, and to ensure compliance. Included in this chapter is a brief narrative and rating analysis of the potential impacts from the proposed five prioritized projects identified, and the Stakeholder Consultation exercise undertaken during the course of the initial Lae – Nadzab Urban Development Project with suggestion of a proposed long-term stakeholder consultation mechanism for the duration of the Project implementation.

14.1 PNG Social Environmental Assessment System

14.1.1 Legal and Administrative Framework

Any determined specific Project to be developed as a Lae-Nadzab Urban Development Project, is bound to meet the legislative and administrative system requirements of PNG. Also, consistent with the international financing and development Guideline requirements, the Project will, on recognition of inadequacies in PNG laws, is obliged to meet relevant and applicable JICA and IFC Performance Standards and Guidelines, thereby ensuring it is consistent with internationally accepted standard practice, as far as practicable.

(1) PNG Legal and Administrative Requirements

By virtue of the Constitution and the sovereignty of PNG, all its enacted legislation and regulations apply to any person or entity within the confines of the national jurisdictional boundaries. In the context of the current Lae-Nadzab Urban Development Project, Lands Act 1996, Physical Planning Act 1989, and Environment Act 2000 are the most important legislation with respective administrative processes that govern and regulate urban development, and the environment and socioeconomic aspects of the Project

(2) PNG Constitution

The PNG Constitution expressly states the national goals and directives describing the aspirations and principles for the development of the nation, which states:

"*We declare our fourth goal to be for Papua New Guinea natural resources and environment to be conserved and used for the collective benefit of us all; and be replenished for the benefit of our future generations*".

This obliges both the PNG Government and development partner to undertake responsibility and diligent implementation of the Project providing adequate levels of protection to the biophysical and socio-economic environment, to ensure a sustainable Project that will meet the needs of the current and the future generations.

(3) Other specific and Relevant PNG Legislations

In addition to PNG Constitution, there are other specific PNG legislations that obligate compliance on the part of the Government and it development partners. Specific to legislative and administrative requirements of the Lae – Nadzab Urban Development Project implementation the following laws matter most important:

Lands and Physical Planning Act, Boundary Commission Act, and Environment Act 2000 which covers, EIS Approval Process, Environment Permit Management, Social and Assessment.

1) Lands and Physical Planning Acts

<u>Land Act</u>

The Lands Act is the principle legislation governing any matters relating to land, land lease, and or

acquisition, for development.

Integrated Land Act

Integrated Land Group (ILG) Act is a specific provision under the legislation that makes it a mandatory requirement for customary landowners to formally register their groups and their land.

Physical Planning Legislation

The Physical Planning legislation is the principle legislation governing all matters relating to urban development.

Social Mapping and Landowner Identification: This is a critical process requirement in any development Project especially involving use of customary or private land. In the extractive industry such as mining, petroleum, energy, there are specific provisions in the respective legislations that provide specific provisions for undertaking social mapping process to identify rightful landowners for the purpose of any resettlement, royalty or compensation payments.

Community resettlement: Any specific legislation that caters for such requirement requires (further search and confirmation)

Compensation: Any specific PNG law to this requirements confirmation though it is understood that the Office of the Valuer General set the monetary value for compensation in any Project development.

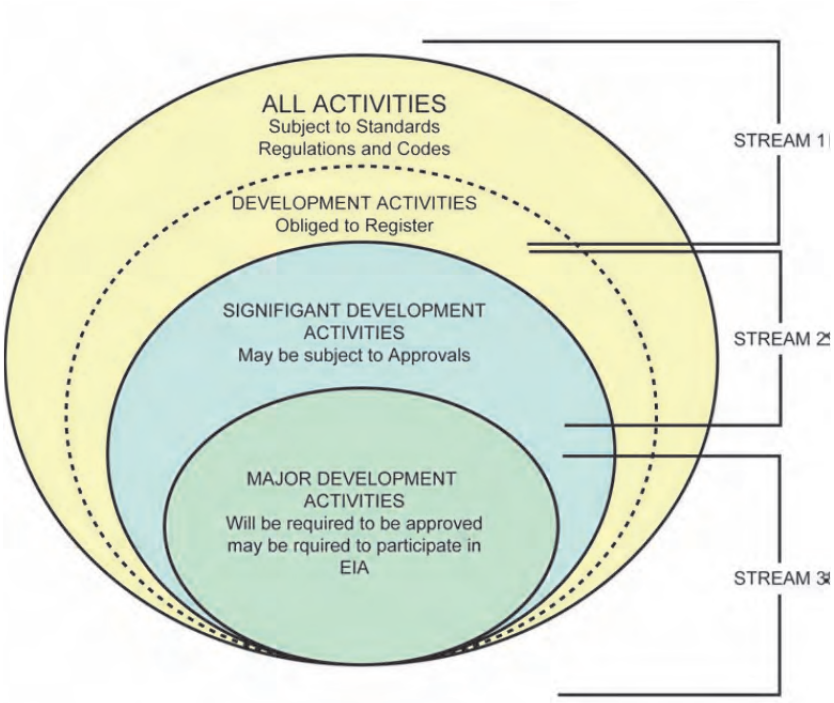
Environment Act 2000

The Environment Act gives effect to the PNG National Goals and Directive Principles, particularly the fourth national goal of environment conservation. The Environment Act 2000 aims to protect and manage PNG natural resources by setting environmental objectives and by establishing processes which aid the observance of the objectives. 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.

The Environment (Prescribed Activities) Regulation 2002 describes specific activities under three different categories as Level 1, Level 2 and Level 3. Thus, depending on the nature, scale and size of the proposed Project activity for the Lae – Nadzab Urban Development Project, the proposed Project will be subjected to these different levels of requirements.

The Environment Act 2000 requires any development of a Level 2 and Level 3 activities to acquire an environment permit from the CEPA. These two Levels activities requirements come under Schedules 1 and 2 that provide description of specific activities under various categories.

Under s. 48 of the Environment Act 2000, a person (including a corporation) who proposes to carry out a level 2 or Level 3 activity must register that intention with the Director of Environment, via a ‘Notification of Preparatory Work on Level 2 or Level 3 Activities.

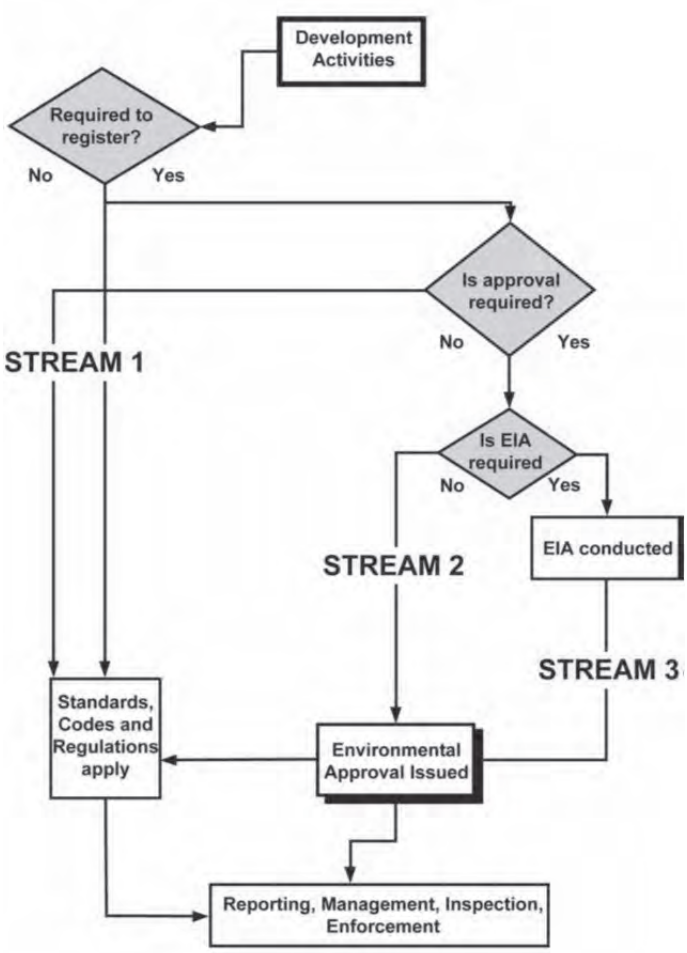


Source: Policy Making and Implementation: Studies from Papua New Guinea, Chapter10

Figure 14.1.1 PNG's Different Regulatory Streams

2) EIA Approval Process

The approval process is represented in the figure below.



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

Figure 14.1.2 PNG's Environment Regulatory Framework under Environment Act

Section 50 of the Environment Act 2000, a person (including a corporation) requires the proponent to undertake an Environment Impact Assessment which entails:

a) Submission of an Environmental Inception report (EIR) to CEPA under s. 52; and

b) Submission of an Environment Impact Statement (EIS) to the CEPA under s. 53.

The environmental impact assessment is primarily to focus on activities relating to the activities to be undertaken in the Project implementation. Under Section 62, no application for an environment permit to conduct Level 3 activities will be accepted unless an environmental impact assessment has been conducted.

Under Section 53 of the Environment Act 2000, the EIS is submitted to the Managing director of the CEPA who:

a) Has 30 days to determine that the EIS meets the guidelines before it is made available for public review;
b) Informs the proponent of the length of the assessment period;
c) May refer the EIS to a number of bodies, such as an environment consultative group or a public enquiry committee. If a provincial committee has been established, the Director must refer the EIS to the committee for its comments. Independent review may also be commissioned by the CEPA;
d) After the preliminary assessment period, make the EIS available for public review; and
e) May require the proponent to make public presentation or submit a program of public review;
f) Following public review, must make a decision to accept or reject the EIS

3) Environment Permit Management

Level 1 Activity**.**

Level 1 activities are those that require a minimum level of environmental protection. Regulation of such activities is based on standards, codes and regulations which set benchmarks for environmentally acceptable activities. For example, maximum discharge levels, ambient quality standards for receiving environment, codes of practice, guidelines for best/acceptable practice. In cases of non-compliance, environmental protection orders, clean-up orders and emergency directions may be issued.

Level 2 Activity

Level 2 activities are those that require a framework of environmental approvals allowing for water discharge permits, or licensing for importation, sale and use of environmental contaminants and for site-specific environmental conditions to be set for these activities which have more significant potential impacts. Level 2 activities are regulated by means of conditions in environmental permits, environmental improvement plans and environmental management programs.

a) An activity listed in Schedule 1 (Annex 1) is a Level 2 activity for the purposes of the Act.

b) An activity that falls into a Level 2 activity is further classified into Category A activity or Category B activity for the purposes of the Act.

Level 3 Activity

Level 3 activities cover those with the potential of major environmental impact and are projects of national significance or of a large scale. Such activities are subject to a process of public and detailed considerations of environmental implication through the EIA process.

An activity listed in Schedule 2 (Annex 2) is a Level 3 activity for the purposes of the Act.

4) Amalgamation of Permit Application

Where an activity involves two or more categories of Level 2 or Level 3 activity or both, an application for a permit in relation to that activity shall identify all the categories of Level 2 or Level 3 activity that are relevant to the application.

a) Environmental Impact Statement

EIS describes the Environmental and Social Management Frame Work for any Project development. (Chapter 21- DEC publication GL – Envi/02/2004)

b) Social Assessment

The Environment Act 2000 requires that the likely social impacts of a proposed activity are set out in the EIS in accordance with the issues identified in the EIR. The following CEPA guidelines apply to social assessments: (Section 51 –Environmental Act 2000)

In accordance with this Guideline requirement the proponent will conduct Social Impact Assessment of the Project Area that will also cover health and cultural heritage.

5) Other Relevant Legislations

The table below provides a summary of other relevant PNG Acts and Regulations applicable to Project development.

Table 14.1.1 Project related Laws of PNG

PNG Legislation	Applicable Regulation	Applicable Guidelines
PNG Constitution 1975		
Environment Act	• Environmental (Fees and Charges) Regulation 2002 • Environmental (Permits) regulation 2002 • Environmental (Prescribed Activities) Regulation 2002	

PNG Legislation	Applicable Regulation	Applicable Guidelines
	• Environmental (Councils Procedure) Regulation 2002 • Environmental (Water Quality Criteria) Regulation 2002	
Fauna (Protection and Control) Act 1982Conservation Areas Act 1978		
National Parks Act 1982		
International Trade (Fauna and Flora) Act 1979	• International Trade (Fauna and Flora) (Fauna) Regulation 1982	
Crocodile Trade (Protection) Act (Chapter 213)		
Forestry Act 1991		
Employment Act 1978	• Employment Regulation 1980	
Employment of Non – Citizens Act 1978	• Employment of Non – Citizens Regulation 2008	
Industrial Organizations Act 1962	• Industrial Organizations regulation 1963	
Industrial Relations Act 1962	• Industrial Relations Regulations 1972	
Workers Compensation Act 1978	• Workers Compensation Regulation 1983	
Discriminatory Practices Act 1963		
HIV / AIDS Management and Prevention Act 2003		
Child Welfare Act 1961		
Land Act 1996	• Land Regulation 1999	
Land Groups Incorporation Act 1974	• Land Groups Incorporation Regulation 1974	
Land registration Act 1981	• Land registration regulation 1991	
Building Act 1971	• Building Regulation 1994	
Customs Act 1951	• Customs (Prohibited Imports) regulation 1973 • Customs (Ad Valorem Duties) regulation 1987 • Customs (Personal Effects) regulation 1995 • Customs (Prohibited Exports) Regulation 1963 • Customs (Prohibited Imports) regulation 1973 • Customs (Prohibition of Trade with South Africa) regulation 1977	
Fire Service Act 1962	• Fire Service Regulation 1966	
Industrial Safety, health and Welfare Act 1961	• Industrial Safety, health and Welfare Regulation 1965	Industrial Safety (Building Works) order 1967
Inflammable Liquid Act 1963	• Inflammable Liquid Regulation 1968	
Motor Traffic Act 1950	• Motor Traffic Regulation 1967	
National Cultural Property (Preservation) Act 1965	• National Cultural Property (Preservation) Regulation 1965	
Licensing Heavy Vehicles Act 1977	• Licensing Heavy vehicles regulation 1977	
Road Maintenance Act 1971	• Road Maintenance Regulation 1973	

PNG Legislation	Applicable Regulation	Applicable Guidelines
Organic law on provincial Governments and local –level Governments 1998		
Public Health Act 1973	• Public Health (Drinking Water) Regulation 1984 • Public Health (Infectious Diseases) Regulation 1973 • Public Health (Mental Disorders) Regulations 1962 • Public Health (Paint) Regulation 1973 • Public Health (Sanitation and General) Regulation 1973 • Public Health (Septic Tanks) Regulation 1973 • Public Health (Sewerage) Regulation 1973	
Food Sanitation Act 1991		Vehicle and Machinery Workshops – Petroleum Storage, Resale, and Usage Sites 1997
		Papua New Guinea Environmental Code of Practice for Sanitary Landfill sites PNG 2001

Source: Prepared by JICA Project Team based on the multiple data source from the PNG government.

6) International Obligations

Table 14.1.2 summaries the international agreements, treaties, conventions and protocols to which PNG Government is a signatory and identifies those aspects of the Project to which they may be relevant

It is worth noting that these 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.

Table 14.1.2 Summary of International Obligations

Title	Objective	Relevance
International Plant Protection Convention (1976)	Promotes international cooperation to control pests and diseases of plants and plant products	Construction hygiene
Convention on Biological Diversity (1992)	Preserving and sustaining biological diversity	Biodiversity studies and management
Convention on International Trade in Endangered Species of Wild Fauna and Flora (1990)	To ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Biodiversity studies and management
Convention for the Protection of the natural resources and Environment of the South pacific Region (1990)	Protection, development and management of the South pacific marine and coastal environment	Biodiversity studies and management
Convention on Wetlands of International Importance especially as Waterfowls habitat (Ramsar Convention) (1993)	An international regime for the conservation and wise use of wetlands and waterfowl populations	Biodiversity studies and management
Convention Concerning the Protection of World Cultural Heritage and Natural Heritage (1972)	An international regime for the protection of indigenous cultural and environmental heritage.	Management and protection of cultural heritage sites, traditions and natural features during Project implementation / constructions.
United Nations Framework Convention on Climate Change (1992) (Kyoto Protocol)	The reduction of negative changes to the earth's climate, with a particular focus on greenhouse gases. Places onus on industrialised countries to reduce emissions. Developing countries like PNG are currently exempt from the reduction requirement for now.	Greenhouse gas emissions to be reported to the Office of Climate Change

Title	Objective	Relevance
Convention on the Conservation of the Migratory species of Wild Animals (1970)	Protection of migratory animals and their habitats, and the prevention, reduction and control of factors that endanger them.	Management of migratory species of terrestrial, marine and avian species of wild animals.
Convention for the Protection of Natural Resources and Environment of the South Pacific Region (Noumea Convention)	Prevent, reduce and control pollution from any source and to ensure sound environmental management and development of natural resources, using the best practicable means available and in accordance with capabilities	Compliance with standards and protocols
Vienna Convention for the Protection of the Ozone Layer (the Vienna Convention) (1993) and the Montreal protocol on Substances that deplete the Ozone Layer (Montreal Protocol)	Protection of the Ozone Layer	Compliance with standards and protocols
The Basel convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989) (Basel Convention)	Reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes and the restriction of Transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management. A regulatory system applying to cases where Transboundary movement are permissible	Compliance with standards and protocols
Rotterdam Conversion (adopted on 10 September 1998, entered into force on 24th February 2004)	Promote shared responsibility and cooperative efforts in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm and to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision – making process on their import and export and by disseminating these decisions.	Compliance with standards and protocols
Convention to ban the importation into the Forum Countries of Hazardous Wastes and radioactive Wastes and to Control the Transboundary Movement and management of Hazardous within the South pacific region (Waigani Convention) (2001)	Prescription of International trade in hazardous waste and notification procedures, monitoring mechanisms and cooperative authorities.	Plant and material selection for constructions / use
Stockholm Convention on Persistent organic pollutants (POPs) (2004)A legally binding international ban on the use and production of a range of persistent organic pollutants (POPs) includes eight organo – chlorine pesticides, two industrial chemicals and two groups of industrial by-products: doxins and furans.		

Source: Prepared by JICA Project Team based on the multiple data source from the PNG government.

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 contractor are required to comply with, such as IFC, JICA, WB, ADB, and Equator Principles[1] are a few notable ones, where there are inadequacies in PNG Law.

[1] The Equator Principles (EPs) is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making.

7) JICA Requirements for Environmental and Social Guidelines

The JICA Guidelines for Environmental and Social Consideration of April 2010 provides the performance Principles that guides undertaking of Environmental and Social Considerations in ODA Project development. JICA considers the following Principles to be important that have to be met and they are;

A "wide range" of impact must be assessed

The types of impacts addressed by JICA cover a wide range of environmental and social issues.

Measures related to Environmental and Social Considerations must be implemented "from an early stage through to the monitoring stage"

JICA applies a Strategic Environmental Assessment (SEA) when conducting master plan studies etc., and encourages Project proponents etc. to ensure environmental and social considerations from an early stage to a monitoring stage

JICA is responsible for "accountability" when implementing cooperation projects

JICA ensures accountability and transparency when implementing cooperation projects

JICA asks "stakeholders" for their participation

JICA incorporates stakeholder opinions into decision-making processes regarding environmental and social considerations by ensuring the meaningful participation of stakeholders in order to have consideration for environmental and social factors and to reach a consensus accordingly. JICA replies to stakeholders' questions. Stakeholders who participate in meetings are responsible for what they say.

JICA "discloses information"

JICA itself discloses information on environmental and social considerations in collaboration with Project proponents etc., in order to ensure accountability and to promote the participation of various stakeholders.

JICA enhances "organizational capacity"

JICA makes efforts to enhance the comprehensive capacity of organizations and operations in order for Project proponents etc., to have consideration for environmental and social factors, appropriately and effectively, at all times.

JICA makes serious attempts at "promptness"

JICA addresses request of acceleration for the prompt implementation of projects while undertaking environmental and social considerations.

Table 14.1.3 Comparison of the JICA Guideline verses PNG EIA Law
(Comparison Table between JICA Guidelines and PNG Local EIA Law)

No.	JICA Guidelines	EIA Laws of PNG	Gaps between JICA Guidelines and EIA Laws of PNG	Correspondence of the Survey Mission
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	No specific law on involuntary resettlement except recognition of " rights" under the Constitution, and specific requirements for appropriate compensations provisions under various legislations such as the Environment Act 2000, Physical Planning Act 1989, Valuation Act 1967, and Land Act 1996. For projects of Level A or B require full compliance with the EIA and SIA	JICA has Statement of Principles as to what it requires under the Environmental and Social Consideration Guidelines for ODA Project development. In PNG EIA and SIA Law under the Environment Act 2000 Act, Lands Act 1996, Physical Planning Act 1989, and Valuation Act 1976 there are allowances made for the	

No.	JICA Guidelines	EIA Laws of PNG	Gaps between JICA Guidelines and EIA Laws of PNG	Correspondence of the Survey Mission
		requirements of the Environment Act 2000. This involves plan of action for undertaking EIA and SIA. Seeking appropriate social license to operate (Project development) is not only mandatory but also of priority and paramount importance to ensure community consent and active participation, and to ensure success of a Project especially developed involving customary land.	requirements for the provisions of Compensation of communities impacted by Project development. There is no specific PNG law on Involuntary Resettlement per say. There isn't any described administrative protocol or process to follow to see through the Resettlement requirements in both PNG EIA Laws and JICA Guidelines. JICA Guidelines have no specific requirements on rates of compensation but that is catered for under the PNG Laws.	
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	There are specific allowances for mitigation measures and compensation requirements provisions to be applied under the Environment Act 2000, Valuation Act 1967, Physical Planning 1989 and Land Act 1996.	There isn't any described administrative protocol or process to follow to see through the Resettlement requirements in both PNG EIA Laws and JICA Guidelines. JICA Guidelines have no specific requirements on rates of compensation but that is catered for under the PNG Laws.	
3.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-Project levels. (JICA GL)	There are specific allowances for mitigation measures and compensation requirements provisions to be applied under the Environment Act 2000, Valuation Act 1967, Physical Planning 1989 and Land Act 1996.	There isn't any described administrative protocol or process to follow to see through the Resettlement requirements in both PNG EIA Laws and JICA Guidelines. JICA Guidelines have no specific requirements on rates of compensation but that is catered for under the PNG Laws.	
4.	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	The various compensation requirements under the respective Environment, Physical Planning, Lands and Valuation Acts are complementing and enabling.	No specifically described administrative protocol to undertake the resettlement exercise but with the laws of the PNG, it is mandatory requirement.	
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Sections 51, 85, 86 and 87, and Social Impact Assessment Guidelines requirement	No specifically described administrative protocol to undertake the resettlement exercise but with the laws of the PNG, it is mandatory requirement.	

No.	JICA Guidelines	EIA Laws of PNG	Gaps between JICA Guidelines and EIA Laws of PNG	Correspondence of the Survey Mission
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	The Social and Environment Impact Assessments require due diligence and comprehensive undertaking of household surveys, Landowner identifications and census including socio-economic assessments to provide guidance for appropriate compensation payment to be fully complied with and concluded first. This exercise also entails the inevitable plan of action on resettlement where required or needed.	No specifically described administrative protocol to undertake the resettlement exercise but with the laws of the PNG, it is a mandatory requirement	
7.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	It is a mandatory requirement for a fully fledged scheduled community consultation, awareness, education to be undertaken with and among the affected communities to ensure compliance with the Free Prior Informed Consent (FPIC) requirement.	No specifically described administrative protocol to undertake the resettlement exercise but with the laws of the PNG, it is mandatory requirement. Neither are there any specifically described information requirements or process to follow.	
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	The above mandatory requirement is a specialist undertaking by specialist social scientists hence, apply appropriate methods, tools and language. Pidgin Language is second language and is one of the two most common languages spoken by the citizens across the country.	No specifically described administrative protocol to undertake the resettlement exercise but with the laws of the PNG, it is mandatory requirement. Neither are there any described information requirements or process to follow. Given high illiteracy in PNG use of appropriate language understood by the affected people is very important.	
9.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Major Project development to take place on customary land requires full community consultation process to take precedence and continued throughout the Project development implementation schedule, including evaluation and monitoring.	No specifically described administrative protocol to undertake the resettlement exercise but with the laws of the PNG, it is a mandatory requirement. Neither is any described information requirement or process to follow.	
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Social displacement of communities' requiring resettlement is a delicate and sensitive undertaking hence, the specific requirements for compensation under the respective laws of PNG always allows for mandatory grievances mechanism to be put in place to carefully scrutinize, assess, evaluate and attend	No specifically described administrative protocol to undertake the resettlement or grievance exercise but within the laws of the PNG, it is a mandatory requirement.	

No.	JICA Guidelines	EIA Laws of PNG	Gaps between JICA Guidelines and EIA Laws of PNG	Correspondence of the Survey Mission
		to community grievances. Success of any Project development is dependent on community willingness, consent, and active participation – this provides the 'Social license to operate' any Project development.		
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the Project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	Social Impact Assessment process, Section 51, 55, 85, 86, 87 of the Environment Act 2000. It is a mandatory requirement to ensure that all affected parties concerned are duly and appropriately catered for. And for the purpose of meeting scheduled Project activities implementation, strategic community consultation and household survey are critical.	No specifically described administrative protocol to undertake the resettlement, grievance exercise, or conduct baseline studies but within the laws of the PNG, it is a mandatory requirement.	
12.	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	The requirements under the respective laws of the country are encompassing irrespective of status, religion, class or creed. Private property rights are recognised under the Constitution hence, all affected are duly and appropriately compensated for loss of property / assets.	No specifically described administrative protocol to undertake the resettlement, grievance exercise, or conduct baseline studies within JICA and PNG Law requirements but within the laws of the PNG, it is a mandatory requirement and has to be undertaken.	
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Within PNG law requirements and the practice thus far, resettlement have been in cash and provision of alternative land for resettlement. How consistent this is applied vary from place, situation and circumstance. This is an administrative responsibility that falls within the jurisdictions of the Government and its various	No specifically described administrative protocol to undertake the resettlement, grievance exercise, or conduct baseline studies within JICA and PNG Law requirements but within the laws of the PNG, it is a mandatory requirement and has to be undertaken.	

No.	JICA Guidelines	EIA Laws of PNG	Gaps between JICA Guidelines and EIA Laws of PNG	Correspondence of the Survey Mission
		agencies relevant agencies that have to be consulted and involved.		
14.	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	There isn't any specific provision but Section 51, 55, 85, 86, 86, including Social Impact Assessment provides allowance for within the Environment Act 2000. Because it is a sensitive and delicate matter involving displaced people, it is an accepted practice (humane thing to do) to provide for a practically acceptable time period to see to a transition period.	No specifically described administrative protocol to undertake the resettlement, grievance exercise, or conduct baseline studies within JICA and PNG Law requirements but within the laws of the PNG, it is a mandatory requirement and has to be undertaken.	
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	The requirements under the respective laws of the country are encompassing irrespective of status, religion, class or creed. Private property rights are recognised under the Constitution hence, all affected are duly and appropriately compensated.	No specifically described administrative protocol to undertake the resettlement, grievance exercise, or conduct baseline studies within JICA and PNG Law requirements but within the laws of the PNG, it is a mandatory requirement and has to be undertaken.	
16.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	Resettlement is a mandatory requirement and it is incumbent on the Government and the Developer to ensure an effective resettlement plan is put in place to ensure effective conclusion of the resettlement exercise, as it is a costly exercise both for the affected people, the government and the developer, if not carefully and diligently attended to and successfully concluded to the satisfaction of all.	No specifically described administrative protocol / process to undertake the resettlement, grievance exercise, or conduct baseline studies within JICA and PNG Law requirements but within the laws of the PNG, it is a mandatory requirement and has to be undertaken.	

Source: Prepared by JICA Project Team based on the multiple data source from the PNG government.

14.2 Potential Impact and Mitigation Measures

14.2.1 Potential Impacts from the Identified Projects

(1) Industrial Development

A total of five potential development projects have been identified under the Industrial Development Category which the details are provided in Table 14.2.1. The proposed projects identified under the Industrial Development category are underpinned by the economic development potential that is recognised in PNG consistent with the National Government Policy for developing Lae as an industrial hub of Papua New Guinea, and consistent with the Government SME development policy initiative. Lae especially is noted for its abundant natural resources that could be utilized in the proposed industry development initiative with the objective to incubate industrial development in the country along with the development of national capacity to give industrial development that recognition and its real meaning in practice. If developed well the prospects for long-term economic returns have been identified to be enormous. Any negative impacts are pretty limited and confined to initial and duration of the Project development. All the proposed Industrial Development projects

are confined to State Land or on land that are currently being used for such activities, or have been already identified for development where there are no communities living within the areas such as Yalu Industrial Park, Lae Tidal Basin, and Malahang Industrial Estate. Any potential negative impacts can be effectively catered for by applying the existing mitigation measures regime allowed for in the Environment Act 2000.

Table 14.2.1 Socio-environmental Impacts (Industrial development Sector)

Industrial Development Sector: ID				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
ID-1	Metal working Industry Development Centre	It is proposed to select an area near a potential market for machine repair and similar services and designate it as a special zone for focused promotion of the metalworking industry.	Kamkum un	The Metal Industry development will most probably involve road pavement construction within the industry area, water supply, sewerage, building-industry infrastructure development requiring excavation of soil / dirt for the metal industry site development construction. Any potential impacts from this stage of the construction will be for the duration of the metal industry infrastructure establishment. The second stage will be metal works and metal products (cans) production, exhaust-fume, noise, vibration that will be the ongoing nature of the metal industry business activity. From both stages of the metal industry development activities there are likely direct implications on the environment including existing settlements and other establishments. Again, depending on the land area involved, scale, size, and proximity of the construction to human settlements, it might just fall under the Level 2 category of the Environment Planning Act requirement, the specific mitigation requirements apply.
ID-2	Woodworking Industry Development Centre	It is proposed to foster woodworking companies capable of making furniture and woodwork products that meet the actual needs in PNG.	Yalu Industrial Park	The Woodwork Industry development most probably will involve road pavement construction, water supply, and sewerage, building-industry infrastructure development requiring excavation of soil/dirt for the metal industry site development construction. Any potential impacts from this stage of the construction will be for the duration of the woodwork industry infrastructure establishment. The second stage will be wood works and wood products (furniture) production, exhaust/fume, noise, vibration, dust that will be the ongoing nature of the woodwork industry business. From t both stages of the metal industry development activities will have direct implications on the environment including existing settlements and other establishments. Again, depending on the land area involved, scale, size, and proximity of the construction to human settlements, it might just fall under the Level 2 category of the Environment Planning Act requirement, the specific mitigation requirements apply.
ID-3	Industrial vitalization cluster	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	Yalu Industrial Park	This activity most likely will involve education/training hence will have limited to nil implications of any sort except for production of waste requiring appropriate disposal system within the existing waste management system.

Industrial Development Sector: ID				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
		lead to creation of industrial cluster.		
ID– 4	Lae-Nadzab Agro Product Depot establishment	Present impeding factors to implement a food processing businesses are the lack of a product collection and distribution system, the lack of intention for or commitment to commercial utilization of coconuts and other agro-products.	Tidal Basin area	The Agro Product Depot development will most probably involve road, water supply, sewerage, building/industry infrastructure development requiring excavation of soil/dirt for construction that will have direct implication on the environment including existing settlements and other establishments. Depending on the land area involved, scale, size, and proximity of the construction to human settlements, it might just fall under the Level 2 category of the Environment Planning Act requirement. Any potential impacts will most probably be for the duration of the construction period.
ID– 5	Food Processing Industry Development	The proposed Project is designed to develop an industrial estate specialized in food processing with a primary aim to foster the food processing industry.	Malahang Industrial area or Tidal Basin	The Food Processing Industry development most probably will involve road, water supply, sewerage, building/industry infrastructure development requiring excavation of soil/dirt for the industry site development construction. Any potential impacts from this stage of the construction will be for the duration of the food processing industry infrastructure establishment. The second stage will be food processing and food products (canned/bottled/packaged) production, exhaust/fume, noise, vibration, dust, and waste production that will be the ongoing nature of the industry business. From both stages of the metal industry development activities will have direct implications on the environment including existing settlements and other establishments. Again, depending on the land area involved, scale, size, and proximity of the construction and industry to human settlements, it might just fall under the Level 2 category of the Environment Planning Act requirement, where specific mitigation requirements apply.

Source: JICA Project Team

(2) Land Use

A total of twenty potential projects have been identified under the Land Use Category. Four proposed projects identified are associated with Industrial Development (Port North, Yalu, Butibum and Wagan Industrial development) to be developed both on State and customary owned land, eight proposed projects (Nadzab Airport City, Markham Point Service Centre, Old Airport City Development, Labu Tourism, Bumayong Service Centre, Situm Urban Centre, Gabensis Service Centre, and Settlement Area Improvement) are focused on future development of areas as Service Centre Points or suburbs, while one proposed Project is for construction of bypass road connecting the main Highlands Highway from the proposed Yalu Industrial area to Igam Barracks access road connecting to the existing UNITECH, Bumayong, Busu and Situm road. The details on these projects are provided in Table 14.2.2 below.

The proposed Port North and Yalu Industrial Development are on land that have been earmarked for such development while the proposed Butibum and Wagan industrial areas are on customary owned land.

The proposed Suburbs, City, Service Centre development, and Settlement improvement projects are on land areas that are either State or customary owned. The proposed Yalu-Igam access road Project development is on customary owned land.

Potential economic development impact and employment opportunities from the proposed thirteen projects are enormous in the long-term for PNG, Lae and the communities considering the increase

in business/commerce activities opportunities, improvements on road access, and provision of services directly and indirectly that can come about as a result.

Any anticipated serious potential negative impacts on the environment and the communities will be in the areas where the proposed projects for development involve customary land requiring any relocation and resettlement that may be needed. The extent to which any negative impacts on the environment and the communities from the proposed projects, including any resettlement will become clear upon closer assessment and evaluation, otherwise, overall, any negative impact would be minimum provided the required due process for undertaking such challenges, in law, are duly followed and applied, including application of the required mitigation measures regime.

Table 14.2.2 Socio-environmental Impacts (Land use)

Land Use Sector: LU				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
LU-1	Lae Port Tidal Basin North	The important industrial facilities and more integrated long-term land use will be realized as an industrial area of Lae City in the future. This area can be considered for a suitable site to place the sewage treatment facilities and solid waste treatment plant.	Northern area of Tidal Basin	The Port North Zone Industry development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and other establishments. Again, depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period and after the completion of the Project because of the concentration of cargo trucks.
LU-2	Yalu Industrial Park	This Project aims agriculture-related industry agglomerations targeting the original plantation land of Yalu Village. It is also expected to be associated with the residential and commercial development activities.	Yalu [State Land]	The Yalu Industrial Park Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and other establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period and after the completion of the Project because of the concentration of cargo trucks.
LU-3	Wagan Fishery Villa	There are natural resources which have potential to utilize around Wagan, such as landscape conservation of Wagan Fishery Village as a traditional village, sea resort development, and high-classed residential development.	Area along coast to the eastern side of Bumbu River [Customary Land]	Wagan Fishery Park Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and other establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement.
LU-4	Nadzab Airport City	This Project is urban development around Nadzab Airport. It is expected to attract the investment for industrial and commercial developments as well as population increase.	Northern area of Nadzab Airport [State Land and Customary Land]	The Airport development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and other establishments. Again, depending on the land area involved, scale and size of the

Land Use Sector: LU				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
				construction it might just fall under the Level 2 or 3 category of the Environment Planning Act requirement.
LU-5	Ahi Rural Settlement (Ahi Western Villa) Expansion	The vacant undeveloped land except informal settlements and industrial developments is identified for the land development area intended for the residential land use.	Area between Independent Drive and Busu Road [Customary Land]	The development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-6	Markham Bridge Road Side Service Center Development	The development of service industry utilizing location is reasonable with correction and processing of agricultural products from the large hinterland of southern side.	Markham Point [Customary Land]	Markham Service Centre Development will involve major earthworks including road, water supply, sewerage, building / industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Again, depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement.
LU-7	Lae Provincial Growth Centre at Lae Old Airport	Further attractive zone for commercial and business will be formed in Lae Central which is urban core of Lae. Formation of urban center is the immediate goal in this Project site as a part of Growth Center.	Lae Old Airport [State Land]	The Old Airport Urban Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period and after the completion of the Project because of the concentration of vehicles.
LU-8	Situm Growth Centre	The Service Center around Bupu River will be arranged in the vicinity of Situm Village, the gate town to the east of Lae City along Singaua Road.	Situm [State Land]	The New Situm urban Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-9	Labu Garden Villa along Markham River	The continuous network to urban area is expected by the development of new residential and industrial area along this road if realized.	Lab along Markham River [Customary Land]	The Labu Tourism Village Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement.

Land Use Sector: LU				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
				The impact will be for the duration of the construction period and after the Project because of the increase of human activities.
LU-10	Kamkumun Light Industry	It is effective to create the commercial and industrial accumulation models, such as mixed land use of housings and small industrial facilities.	Area between Bumbu River and Independent Drive [Customary Land]	The Butibum Industrial Area Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period and after the completion of the Project because of the increase of vehicles to/from the area.
LU-11	Gabensis Growth Centre	It is expected that local level Service Center is located to develop large community network including small-size commercial activities along Wau Road.	Around Gabensis Village [Customary Land]	The Gabensis Service Centre Development will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement.
LU-12	Suburban Growth Center along Yalu-Igam Bypass	This area is effectively located as Suburban Growth Centre in Lae North to enhance the development of Lae City. The base of urban center will be formed by commercial facilities and open space arrangement to the western side	Southwestern area of Igam [Customary Land]	The Yalu – Igam Hillside urbanization will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the immediate environment including existing settlements and other establishments. Again, depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-13	Eivots Garden City North	This Project is planned in vast land along Yalu-Igam Bypass, it should cope to address the solution for enormous population growth until 2050. The new urban development that incorporates a wide range of development activities is desired.	Area from Igam to Yalu [Customary Land]	The Informal Settlement Living Conditions Improvement Project will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-14	Eivots Garden City South	This Project is planned in vast land along Yalu-Igam Bypass, it should cope to address the solution for enormous population growth until 2050. The new urban	Area from Igam to Yalu [Customary	The Informal Settlement Living Conditions Improvement Project will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment

Land Use Sector: LU				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
		development that incorporates a wide range of development activities is desired.	Land]	including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-15	3-mile Settlement Improvemen t	This area is expected to be Riverside Residential Area because of its attraction as the gateway to Lae Central.		The Informal Settlement Living Conditions Improvement Project will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-16	Malahang Industrial Extension	It is expected that industrial base to be strengthened further and set up public transportation services with the preparation of bus terminals in the future.	Western area of Busu Road [Custom ary Land]	The impact will be for the duration of the construction period and after the completion of the Project because of the concentration of vehicles.
LU-17	Puahom Garden City	This area will have a potential of vast development by proper drainage, and a room for absorbing the large population growth and attracting large-scale facility development.	Area around Puahom Village [Custom ary Land]	The Informal Settlement Living Conditions Improvement Project will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-18	Bubia Industrial Park	Industrial Park has been planned in the position where Highlands Highway and Wau Road branches.	Bubia [State Land]	The impact will be for the duration of the construction period and after the completion of the Project because of the concentration of vehicles.
LU-19	Wampar Gate at 5-6 Miles	This area is expected to be Riverside Residential Area because of its attraction as the gateway to Lae Central.	5-6 Miles [State Land]	The Informal Settlement Living Conditions Improvement Project will involve major earthworks including road, water supply, sewerage, building/industry infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
LU-20	Abongtu Garden Villa	The modified plan for realization of Abongtu development has been basically taken into account	Area along Busu Road	The Informal Settlement Living Conditions Improvement Project will involve major earthworks including road, water supply, sewerage, building/industry

Land Use Sector: LU				
PPA Code	Proposed Project Activities	Scope of Work	Project Location	Potential Impacts
		in this Project proposal.	[Customary Land]	infrastructure development that will have direct implications on the environment including existing settlements and establishments. Depending on the land area involved, scale and size of the construction it might just fall under the Level 2 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.

Source: JICA Project Team

(3) Transport

A total of sixteen projects are proposed under the Transport Category comprising of six major construction projects proposed (Widening of North Bumbu Bridge, Widening of Independence Drive, Widening of Markham Bridge, Construction of Yalu-Igam Highway, Construction of Tidal Basin Bypass Highway and Construction of collector roads in Ahi Rural Kamkumun area), while the remaining five proposed projects are confined to Widening of Bukawa Road, Rehabilitation of Lae City roads, Rehabilitation of two access roads to Labu, construction of PMV terminals and Signalization of major intersections, Rehabilitation of and Widening of Lae City roads, improvement of Bus Stop Terminals, and Building of Jetties. In addition, F/S of Railway construction from Highlands Region to Lae City and two technical assistance projects are proposed. Details of these projects are provided in Table 14.2.3 below.

The importance of improved road access and transportation for economic development underpinned the proposed projects, including connecting the outlier areas from the city to facilitate active participation of the communities in the economic development and easy access to services. The potential economic returns from the proposed Project interventions have been Projected to be enormous overall for the Lae-Nadzab Urban area, and the communities. Likewise, improvements on the Lae City road, drainage and bus stop terminal improvements will bear enormous benefit for the city and its residents. Any negative impacts to the environment and the communities overall would be minimum except for the duration of the Project implementation. Adverse negative impacts would be from any resettlement that may become necessary, the extent to which will only be determined upon closer assessment and evaluation.

Table 14.2.3 Socio-environmental Impacts (Transport)

Transport Sector: TR & TM				
PPA Code	Proposed Project Activity	Scope of works	Location	Potential Impacts
TR-1	Widening of North Bumbu Bridge and related roads	To relieve the bottlenecks of two Bumbu Bridges, the North Bumbu Bridge and related roads are to be widened into four lanes. At same time, existing two lane North Bumbu Bridge is also to be reconstructed as it has serious damage.	North Bumbu Bridge	The road widening activities will involve some earthworks and excavation, and bridge constructions. Again, depending on where and what land area is required for the constructions, potential impact on the environment will be minimum (will be for the construction duration) except for any landownership issues that may arise and any need for resettlement and compensation.
TR-2	Widening of Independence Drive	As soon as the Project no. TR-1 is implemented, the Independence Drive should be widened into four lanes between Taraka and Omeli roundabout in order to accommodate the traffic to be increased by the Project.	Independence Drive	The road widening activities will involve some earthworks and excavation. Again, depending on where and what land area is required for the constructions, potential impact on the environment will be minimum (will be for the construction duration) except for any landownership issues that may arise and any need for resettlement and compensation.

Transport Sector: TR & TM				
PPA Code	Proposed Project Activity	Scope of works	Location	Potential Impacts
TR-3	Widening of Markham Bridge	This is the Project to construct one more single lane bridge parallel to existing Markham Bridge. The existing bridge has only single lane with 3.5m wide, and is operating as one way alternating traffic. It is expected to be choked up in near future.	Markham Bridge	Nil impact except for any earthworks and bridge construction but the impacts which will be minimal to nil. Any impacts will be for the duration of the construction period.
TR-4	Widening of Bukawa Road	This is the Project to widen the single lane section of the Bukawa Road which is located between Bumayong Intersection and POM Bridge into two lanes. This is including the widening of Busu Bridge and Pom Bridge.	One lane section of Bukawa Road	The road widening activities will involve some earthworks and excavation, and bridge constructions. Again, depending on where and what land area is required for the constructions, potential impact on the environment will be minimum (will be for the construction duration) except for any landownership issues that may arise and any need for resettlement and compensation.
TR-5	Signalization of intersections in Lae City	This is the Project to convert roundabouts or uncontrolled intersections into signalized intersections. According to the traffic analysis for 2025, ten intersections in Lae City will exceed their capacities and they are required to be signalized.	Lae City	Nil impact except for traffic congestion during construction
TR-6	Construction of Yalu-Igam Highway	This is the Project for constructing new highway connecting Igam road to the Highlands Highway at Yalu area. The new highway is expected to function as alternative road of the Highlands Highway to exclude through traffic between the east and the west from Lae City center. Moreover, the development of new Garden Citry is proposed along this highway.	Area between Yalu and Igam	The Yalu-Igam Highway construction activity will involve major engineering, earthworks to construct the Highway including constructing bridges and culverts along a forested but very steep Atzera Range covering source and outflow of streams that include Yalu and Busu Rivers. Given the topography and unstable geology of the area, it is a vulnerable to seismic movements hence, prone to landslips. With the presence of landowners and settlements there just might be the need for resettlement, potential impact on the water sources, and agriculture/subsistence land, the proposed activity no doubt will fall under the Category 2 or 3 requirement of the Environment Planning Act. Any major impacts will be for the duration of the Project construction period.
TR-7	Construction of Bypass Highway behind Lae Tidal Basin	This is the Project for constructing new bypass highway connecting Lae Port to the Highlands Highway at 6 Mile. This new highway will function as alternative road of the Highlands Highway to exclude through traffic between Lae Port and Nadzab or Highland area from Lae City.	Area behind Lae Tidal Basin and between Highlands Highway and Markham River	The Bypass Highway Construction Project activity will involve major engineering and earthworks to be construct the Highway including constructing bridges and culverts. The proposed activity will traverse both State and Customary land with potential for resettlement of landowners/communities no doubt will fall under the Category 2 or 3 requirement of the Environment Planning Act. Any major impacts will be for the duration of the Project construction period.
TR-8	Construction of collector roads	This is the Project for construction of new collector roads in the Ahi Rural Kamkumun area enclosed by	Ahi Rural Kam kumun Area	The collector roads construction activity will involve major engineering and earthworks to be construct the roads. The proposed activity will traverse

Transport Sector: TR & TM				
PPA Code	Proposed Project Activity	Scope of works	Location	Potential Impacts
	between Independence Drive and Busu Road	Independence Drive, Busu Road and Telkom Road. This area has currently large open space excepting some informal settlements, and has hardly any road network. As it is close to Lae central area, it has the potential of big expansion of the settlement. Therefore, the collector road network should be developed in this area before the settlement is expanded.	enclosed by Independence Drive, Busu Road and Telkom Road	Customary land with potential for resettlement of landowners/communities no doubt will fall under the Category 2 or 3 requirement of the Environment Planning Act. Any major impacts will be for the duration of the Project construction period.
TR-9	Rehabilitation of Lae City Roads	DOW has made a rapid progression into Lae City roads rehabilitation, and it is still on progress. However there are some deteriorated roads observed and they are required to be rehabilitated.	Lae City	Nil impact except for potential traffic congestion and inconveniences caused during rehabilitation.
TR-10	Rehabilitation of two access roads to Labu area	This is the Project to rehabilitate two access roads in Labu area. The one is to connect Markham Bridge and Labu 1 along the Markham River, the other one is to connect from Markham Bridge toward the south along the foot of mountain. Labu area has three villages, but all of them don't have land access route to Lae City and they are constrained to use boat.	Labu area	The Labu access road construction will involve earthworks and possibly bridge and culvert construction. Again, depending on the design and stretch of the road connection required, any potential impacts will be localized thus, will be minimal. Exceptions will be related to landownership issues and compensation
TR-11	Construction of PMV Terminals	There are three main bus terminals in Lae City, which are in Top Town, Main Market and Eriku. The Top Town terminal has a capacity to accommodate the current traffic of PMVs, but the other two terminals do not have enough spaces and are causing traffic jams. Therefore, it is urgently required to improve these two terminals in Main Market and Eriku. Moreover, new PMV terminal is required in the Airport City, and it will work as hub terminal between urban routes and rural routes (long-distance routes).	Main Market area, Eriku area and Airport City	For improvements of existing terminals at Main Market and Eriku, nil impact except for traffic congestion and any inconveniences caused. For new terminal at Airport City, the construction activities will have direct implications on the environment including existing settlements and other establishments. Again, depending on the land area involved, scale and size of the construction it might just fall under the Level 2 or 3 category of the Environment Planning Act requirement. The impact will be for the duration of the construction period.
TR-12	Feasibility Study for Railway between Highland area and Lae Port	Since there is the demand for long distance freight and passenger traffic between Highland area and Lae, the railway would be alternative of the highway. It is required to conduct the feasibility studies.	Between Lae and Mount Hagen	The extent of any social-environment impact from this proposed Project will be established following a feasibility study. Any potential impact that may arise from the proposed Project will be land issues and ownership.
TR-13	Technical Assistance for PMV Management	Since there is no control over PMV operations, traffic congestion occurs frequently around the terminals and the operations are not well organized. Therefore, it is	—	Nil impact.

Transport Sector: TR & TM				
PPA Code	Proposed Project Activity	Scope of works	Location	Potential Impacts
		required to establish an organization in charge of PMV management under MPA and provide a technical assistance to them.		
TR-14	Technical Assistance for Road Maintenance	Since there is no enough maintenance provided by LULLG who are supposed to maintain the most of the roads in Lae City, road conditions in Lae City are very poor. Therefore it is required to provide a technical assistance regarding road maintenance to LULLG.	—	Nil impact.
TM-1	Construction of Jetties for Labu	The boat transportation is the only way to access to Lae City from Labu area. However, there are no jetties in Labu side, and it is difficult to approach the sandy coast by the boat during tidal waves. Therefore, three jetties for each Labu village are required to be constructed.	Labu area	Nil impact unless there is a plan for any dredging which is unlikely given the bathymetry of Labu coastline.
TM-2	Development of Fisheries Wharf in Wagang	This fisheries wharf development is being planned by Morobe Provincial Administration in cooperation with National Fisheries Authority since 2009 due to the fact that Lae main port is congested with vessels. The wharf will be developed together with fish processing industrial park.	Wagang area	The proposed Wagan Fisheries Wharf Project will involve major engineering and construction work both over the seafront and on land. Potential impact will be erosion from land construction but this will be minimal and for the duration of the construction. Major impact concern will be development of the fish processing infrastructure which will require converting the existing land area which in parts have marsh/swamp and mangrove stands, natural swamp ecosystem and as fishery breeding grounds, but especially affecting Wangang community dependent on mangrove resources and fishing grounds.

Source: JICA Project Team

(4) Storm Water Drainage

A total of six storm water drainage projects were proposed for improving drainage system both for within the city and the rural community settings within the confines of the Lae-Nadzab Urban Development Project Area. The details on these proposed projects are provided in Table 14.2.4.

Effectively, there would be limited impacts from the proposed Project activities with the exception of the activities that have to be undertaken within any customary or privately owned land areas during drainage construction. Otherwise the long-term economic benefits for the Lae-Nadzab Area would be enormous through effective mitigation of the flash flooding and erosion effects on the road accesses, bridges, communities and private properties. Lae is one of the wettest areas known in PNG and so has the devastating effects from flash flooding hence, the urgent need for proper design and construction of drainage system is paramount.

Table 14.2.4 Socio-environmental Impacts (Storm Water Drainage)

Storm Water Drainage Sector: SD				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impacts
SD-1	River improvement in the lower reaches of the Markham River	Since the Markham River has not been maintained, the risk of flood damage is expected that the ever-increasing. The Project includes the following scopes: ・Construction of embankment (length: 1,000m, volume: about 330,000m3) ・Excavation of riverbed (length: 1,000 m, volume: about 3,510,000 m3)	The lower reaches of the Markham River	Nil impact except for any land issues and where issues of resettlement may arise.
SD-2	Ground Raising in the right bank site of the Markham Bridge in the Markham River	Since the Markham River has not been maintained, the risk of flood damage is expected that the ever-increasing. Although, the embankment of 180,000 m3 is necessary to be constructed, there is any major facilities in the vicinity of the Markham Bridge and the development planned site is limited to1ha – 2ha, and moreover, this might influence the Markham Bridge to replace it. Therefore, approach by raising about 3m of development site (soil volume: 60,000 m3) is determined to be economic. The Project includes the following scopes: ・Raising the ground level (area: 2ha, soil volume: about 60,000m3)	The right bank site of the Markham Bridge	Nil impact except for any land issues and where issues of resettlement may arise.
SD-3	River improvement in the Erap River	Since the Erap River has not been maintained, the risk of flood damage is expected that the ever-increasing. The Project includes the following scopes: ・Excavation of riverbed (length: 3,400m, volume: about 3,630,000 m3)	The vicinity of Nadzab Airport	Nil Social – environment impacts
SD-4	River improvement in the lower reaches of the Bumbu River	Since the Bumbu River has not been appropriately maintained, the risk of flood damage is expected that the ever-increasing. The Project includes the following scopes: ・Excavation of riverbed (length: 5,000m, volume: about 1,300,000 m3) Because river improvement in the downstream is prior to the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.	The lower reaches of the Bumbu River	Nil Social – environment impacts
SD-5	River improvement in the upper reaches of the Bumbu River	Since the Bumbu River has not been appropriately maintained, the risk of flood damage is expected that the ever-increasing. The Project includes the following scopes: ・Excavation of riverbed (length: 7,500m, volume: about 1,370,000 m3) Because river improvement in the downstream is prior to the upstream, it is necessary to implement the river improvement in the lower reaches prior to the upper reaches.	Erap, The upper reaches of the Bumbu River	Nil Social – environment impacts

Storm Water Drainage Sector: SD				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impacts
SD-6	River improvement Project in the lower reaches of the Busu River	Since the Busu River has not been appropriately maintained, the risk of flood damage is expected that the ever-increasing. The Project includes the following scopes: ・Excavation of riverbed (length: 12,000m, volume: about 32,650,000 m3)	The lower reaches of the Busu River	Should be limited to nil impacts depending on the land area needed to undertake the construction where customary land might be needed. Ground truthing is needed for verification.

Source: JICA Project Team

(5) Water Supply

A total of nine water supply related projects were proposed largely based on Water PNG plans, including proposal for strategic water supply facilities establishment at Yalu, Gabensis, and Nadzab Areas. Details of these proposed projects are provided in Table 14.2.5. Effectively, the overall objective is to improve water supply in the Lae-Nadzab Area to meet the fast growing population and their demand for water in the long-term. Economic potential to accrue to the Lae City and the residents in the long-term are enormous. The potential negative impacts are also limited with the exception of dealing with the customary landowners on whose land would be used to develop water supply. The need for proper water supply to the surrounding communities and settlements is paramount, and no doubt the communities would directly benefit enormously and would certainly be willing to actively participate to see to the realization of the water supplied to their communities. In doing so this would minimize any adverse demand from the landowners/communities. It has been noted over and over again over the years during extreme weathers (both wet and dry) that landowners and communities are directly affected and suffer terribly as has been experienced in the 2015 El Nino dry season.

Table 14.2.5 Socio-environmental Impacts (Water Supply)

Water Supply Sector: WS				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impact
WS-1	Water Supply Development in Lae	Water source Submersible pump Purification plant Booster pump Reservoir tank Pipeline	Lae urban and Ahi Rural between Markham River and Busu River	Any likely impacts will result from use of customary land where land issues and compensation will arise. Otherwise, if on State land, impacts should be limited to nil. Ground truthing needed for verification.
WS-2	Water supply at SITUM	Water source Submersible pump Purification plant Reservoir tank Pipeline	Situm area (composite type)	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification.
WS-3	Water supply at Puahom Garden City	Water source Submersible pump Purification plant Reservoir tank Pipeline	Puahom Garden City	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification.

Water Supply Sector: WS				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impact
WS-4	Water supply at Bubia Industrial Park	Water source Submersible pump Purification plant Reservoir tank Pipeline	Bubia Industrial Park	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification.
WS-5	Water supply at Yalu Industrial Park	Water source Submersible pump Purification plant Reservoir tank Pipeline	Yalu (composite type)	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification
WS-6	Water supply in Nadzab Airport City	Water source Submersible pump Purification plant Reservoir tank Pipeline	Nearby area of Nadzab Airport (composite type)	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification. The area is flood prone.
WS-7	Water supply at Markham Point (Bridge)	Water source Submersible pump Purification plant Reservoir tank Pipeline	Markham Point (composite type)	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification. The general area is flood prone.
WS-8	Water supply at Gabensis	Water source Submersible pump Purification plant Reservoir tank Pipeline	Gabensis area Community Center (composite type)	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification. The general area is hilly tapering off onto a flood plain.
WS-9	Water supply at Labu Garden Villa along Markham River	Water source Submersible pump Purification plant Reservoir tank Pipeline	Labu Garden Villa along Markham River	It depends on the land area, design and construction otherwise there should be nil impacts except for the duration of the facility construction. Again requires ground truthing and verification. Special attention should be paid to the environmental impact on the lagoon.

Source: JICA Project Team

(6) Sewerage

A total of nine projects were proposed for strategic construction and development of sewerage treatment facilities within the Lae City, and the outlier areas such as Gabensis, Nadzab, Yalu, Nine Mile to Lae, and Waste Sludge Treatment Facility for Lae. Detail descriptions can be seen in the Table 14.2.6. Any negative implications, again, are very much limited except for the duration for the construction. Major challenge would be dealing with the customary landowners and their communities on whose land would be used for the development and establishment of the proposed

treatment facilities. Economic returns in the long run for the Lae city and the affected communities would be enormous considering the improvement in health and hygiene as a result.

As is required by law under the Environment Act, full compliance is mandatory from impact assessment, applying mitigation measures and monitoring over the course the Project construction besides seeking the people informed consent.

Table 14.2.6 Socio-environmental Impacts (Sewerage)

Sewerage Sector: SE				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impacts
SW-1	Sewerage Development in Lae Phase-1	To develop sewer networks in Lae urban and Ahi Rural between Markham River and Busu River, Southern area than Taraka.	Lae urban and Ahi Rural between Markham River and Busu River, Southern area than Taraka	Nil socialenvironment impacts except for customary/private owned properties land areas, and the inconvenience caused during the construction.
SW-2	Sewerage Development in Lae Phase-2	To develop / extend sewer networks in Lae urban and Ahi Rural along with city development	Lae urban and Ahi Rural	Nil socialenvironment impacts except for customary/private owned properties land areas, and the inconvenience caused during the construction.
SW-3	Suburban Central Development along Yalu-Igam Bypass	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (1,500m3/d) Sewer network (140ha) PH-2: Sewage Treatment Plant (3,000m3/d extension) Sewer network (400ha)	Suburban Central along Yalu-Igam Bypass	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SW-4	Eivots Garden Center North sewerage Development along Yalu-Igam Bypass	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (3,000m3/d) Sewer network (230ha) PH-2: Sewage Treatment Plant (15,000m3/d extension) Sewer network (820ha)	Eivots Garden Center North along Yalu-Igam Bypass	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SW-5	Eivots G.C. South Sewerage Development	To develop the following facilities along with city development: Sewage Treatment Plant (7,000m3/d) Sewer network (700ha)	Eivots G.C. South	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SW-6	Puahom Garden City sewerage Development	To develop the following facilities along with city development: Sewage Treatment Plant (7,000m3/d) Sewer network (800ha)	Puahom Garden City	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SW-7	Yalu Industrial Park sewerage Development	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (1,900m3/d) Sewer network (90ha)	Yalu Industrial Park	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.

Sewerage Sector: SE				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impacts
		PH-2: Sewage Treatment Plant (1,900m3/d extension) Sewer network (60ha)		
SW-8	Airport City sewerage Development	To develop the following facilities along with city development: PH-1: Sewage Treatment Plant (1,900m3/d) Sewer network (120ha) PH-2: Sewage Treatment Plant (7,600m3/d extension) Sewer network (780ha)	Airport City	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SW-9	Labu Tourism Village Development	To develop the following facilities along with city development: Sewage Treatment Plant (6,000m3/d) Sewer network (250ha)	Labu Tourism Village	The proposed tourism village development will involve engineering and construction both over the seafront and on land. Major impact concern will be development of infrastructure affecting the environment of natural swamp and lagoon.

Source: JICA Project Team

(7) Waste Management

A total of four projects were proposed under the category of solid Waste Management. One was to rehabilitate the existing Dump Site and the other was to develop and establish another site applying Semi-Sanitary Landfill Technology. The development would take place on State Land especially on the existing dump site thus, there would be minimum to no issues dealing with customary landowners. Any environment impact from the proposed Project development would be minimum to none but for the duration of the construction. Economic benefits to accrue to the Lae-Nadzab Area would be enormous with use of the proven waste management technology but more so improvements in the health, hygiene and safety of the city residents.

Table 14.2.7 Socio-environmental Impacts (Waste Management)

Waste Management Sector: WM				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impacts
WM-1	Rehabilitation of the Existing Dumpsite	1. To rehabilitate the existing dumpsite, i.e. Second Seven Dumpsite, with proper facilities such as levelled ground, drainage system, walls, entrance, administration office, to which proper waste management technology such as semi-sanitary landfill technology should be applied.	Second Seven Site, Lae City	Nil social-environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
WM-2	Tidal Basin North landfill construction	As the candidate site for the facility, hinterland of Tidal Basin (Tidal Basin North) with 15 ha (landfill area) is Projected. As the associated facilities require roughly 1 ha, land with 16 ha in total should be ensured at the site.	Tidal Basin west end at the Markham River Bank	Nil social – environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.

Waste Management Sector: WM				
PPA Code	Proposed Project Activity	Scope of Works	Location	Potential Impacts
WM-3	Capacity development of landfill operation	Proper management should be implemented at Second Seven Dumpsite. Technical assistance should be provided to government officers, who are actually working at the dumpsite, from international cooperation agencies such as JICA.	Morobe Provincial Government, LULLG	Nil social – environment impacts.
WM-4	Nadzab (Airport City) landfill construction	Since airport city is too far from Lae Urban area to bring the wastes generated in this area to Lae Urban area, new sanitary landfill should be prepared separately for the airport city. Required land area is 1.5 ha in total till 2050 at the site, which includes 0.5 ha land for the associated facilities. Cell-I with 1.0 ha landfill area is to be used till 2045.	Nadzab Area	Nil social – environment impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.

Source: JICA Project Team

(8) Social Service

A total of six projects are proposed under the Social Services Category for provision of improved social services in education and health within the Lae City and the surrounding areas. The services are to be provided for within the existing facilities or areas where the communities and the government determine appropriate thus, any negative impacts arising out of the proposed projects would be minimal. Details of the proposed Social Service Project are provided in Table 14.2.8.

Table 14.2.8 Socio-environmental Impacts (Social Service)

Social Services Sector: SS				
PPA Code	Proposed Project Activities	Scope of Works	Location	Potential Impacts
SS-1	Facility capacity and accessibility improvement for the primary schools in the Project Area	Increasing capacity of each school including building of new schools to meet demand according to Ward level population and reduce walking distance according to the populated location to suite school sites are mandatory to improve educational environment for all school aged children.	Overall Project Area in each Ward	Nil social-environment impacts if it is rehabilitation, maintenance and expansion of existing infrastructure. If development is to take place on new land area, there will be limited impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SS-2	Capacity and service quality improvement for the healthcare facilities in the Project Area	Current health clinics and aid posts in Lae Urban area are inadequate to provide the services required by the people requiring improving each healthcare facilities and services. In the outside of LULLG area	Overall Project Area in each Ward	Nil social-environment impacts if it is rehabilitation, maintenance and expansion of existing infrastructure. If

Social Services Sector: SS				
PPA Code	Proposed Project Activities	Scope of Works	Location	Potential Impacts
		are only provided with small aid posts with minimum services, requiring larger facilities with increased capacities to provide better services.		development is to take place on new land area, there will be limited impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SS-3	Public park and amenity facility development in the Project Area	Developing public amenity, facilities and parks to meet demand of recreational activities among local people is mandatory to improve livelihood and living environment.	Lae urban area	Nil social – environment impacts if it is rehabilitation, maintenance and expansion of existing infrastructure. If development is to take place on new land area, there will be limited impacts except for customary and private owned land and properties, and the inconvenience caused during the construction.
SS-4	Ward level community center development in the Project Area	There are very limited community gathering and function facilities in the Project Area, and developing Ward level Community Centers to meet demand of information sharing and gathering among local people is mandatory to improve communication among local population.	LULLG and other development target area	Nil Impacts
SS-5	Police station development in the Project Area	The crime commitment is increasing in all over the PNG region. Thus, increasing capacity and service level of police facility and officials to meet demand according to Ward level population is mandatory to improve security level of local population.	All Project Area, especially where more increase of population is expected and where communities are so isolated or remote from urban areas.	Nil Impacts
SS-6	Sports facility development in Lae urban area	Expanding and improving the sports facility in Lae to meet demands of not only regional but also national level sports activities is mandatory to add more attractiveness of the Lae-Nadzab Area for the nationwide needs. This is Lae City Administration Projected development Plan incorporated in the new Master Plan.	Lae City: The location at the existing Sir Ignatius Kilage Sports Facility	Nil social-environment impacts

Source: JICA Project Team

14.2.2 Positive and Negative Impacts Rating from Proposed Projects

Consistent with the requirements of the Environment Act 2000 and the JICA Environmental and Social Guidelines, the following Impacts Rating assessment were done to illustrate the extent to any impacts (positive and negative) that would arise from the proposed projects describe above. The details of these Potential Impacts Ratings are provided in Table 14.2.9.

Table 14.2.9 Ratings of Predicted Impacts - Industrial Development & Land Use

IMPACTS		A: Serious adverse impacts are expected. B: Some adverse impacts are expected C: Extent of impact is unknown at this stage. D: Positive Impact is expected E: No adverse impact is expected																								
		Industrial Development					Land Use																			
		ID - 1	ID - 2	ID – 3	ID - 4	ID - 5	LU – 1	LU – 2	LU – 3	LU - 4	LU - 5	LU - 6	LU - 7	LU - 8	LU - 9	LU - 10	LU - 11	LU - 12	LU - 13	LU - 14	LU - 15	LU - 16	LU - 17	LU - 18	LU - 19	LU - 20
Social Environment	Involuntary settlement	E	E	E	E	E	E	E	C	C	C	E	E	C	E	C	C	E	C	C	C	C	C	C	C	C
	Local economy	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	Employment, Livelihood	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	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	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Existing Social Infrastructure & services	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	The poor, indigenous, and Ethnic People	E	E	E	E	E	E	E	C	C	C	E	E	C	C	C	C	E	E	C	C	C	C	C	C	C
	Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Cultural heritage	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Local Conflict of Interests	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Water Usage & Rights	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Sanitation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Accident	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	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	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Natural Environment	Geographical Feature	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Soil Erosion	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Ground Water	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Coastal Zone	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Meteorology	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Landscape	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Global Warming	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Pollution	Air pollution	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Water Pollution	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Solid Waste	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	Noise and Vibration	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Ground Subsidence	E	E	E	E	E	E	E	C	C	C	E	E	C	C	C	C	E	C	C	C	C	C	C	C	C
	Offensive Odour	B	B	B	B	B	B	B	B	C	E	C	E	C	C	B	C	C	E	E	C	C	C	C	C	C
	Bottom Sediment	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

Source: JICA Project Team

Table 14.2.10 Ratings of Predicted Impacts- Transport

IMPACTS		A: Serious adverse impacts are expected. B: Some adverse impacts are expected C: Extent of impact is unknown at this stage. D: Positive impact is expected E: No adverse impact is expected															
		Transport															
		TR - 1	TR - 2	TR - 3	TR - 4	TR - 5	TR – 6	TR – 7	TR – 8	TR - 9	TR - 10	TR - 11	TR - 12	TR - 13	TR - 14	TM - 1	TM - 2
Social Environment	Involuntary settlement	B	B	E	B	C	B	C	B	E	C	E	B	E	E	E	E
	Local economy	D	D	D	D	D	D	D	D	D	D	D	D	E	E	D	D
	Employment, Livelihood	D	D	D	D	D	D	D	D	D	D	D	D	E	E	D	D
	Land use, Utilization of Local Community	C	C	C	C	C	B	C	C	C	C	C	C	E	E	C	C
	Existing Social Infrastructure & services	C	C	C	C	C	C	C	C	C	C	C	C	E	E	C	C
	The poor, indigenous, and Ethnic People	C	C	E	C	E	B	E	B	E	C	E	B	E	E	E	E
	Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C	C	C	E	E	C	C
	Cultural heritage	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Local Conflict of Interests	C	C	C	C	C	C	C	C	C	C	C	C	E	E	C	C
	Water Usage & Rights	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Sanitation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Accident	C	C	C	C	C	C	C	C	C	C	C	C	E	E	C	C
	Infectious Diseases such as HIV AIDS	C	C	C	C	C	C	C	C	C	C	C	C	E	E	C	C
Natural Environment	Geographical Feature	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Soil Erosion	C	C	C	C	C	B	C	C	C	C	C	C	E	E	C	C
	Ground Water	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Coastal Zone	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Meteorology	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Landscape	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Global Warming	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Pollution	Air pollution	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Water Pollution	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Solid Waste	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Noise and Vibration	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Ground Subsidence	C	E	E	E	E	C	C	E	E	C	E	C	E	E	E	E
	Offensive Odour	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Bottom Sediment	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

Source: JICA Project Team

Table 14.2.11 Ratings of Predicted Impacts- Storm Water Drainage, Water Supply & Sewerage

IMPACTS		A: Serious adverse impacts are expected. B: Some adverse impacts are expected C: Extent of impact is unknown at this stage. D: Positive impact is expected E: No adverse impact is expected																						
		Storm Water Drainage						Water Supply									Sewerage							
		SD - 1	SD - 2	SD - 3	SD - 4	SD - 5	SD - 6	WS - 1	WS - 2	WS – 3	WS - 4	WS - 5	WS - 6	WS – 7	WS - 8	WS - 9	SE - 1	SE - 2	SE - 3	SE - 4	SE - 5	SE - 6	SE - 7	SE - 8	SE - 9
Social Environment	Involuntary settlement	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Local economy	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	Employment, Livelihood	D	D	D	D	D	D	D	D	D	D	D	D	D	D	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	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Existing Social Infrastructure & services	C	C	C	C	C	C	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	The poor, indigenous, and Ethnic People	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Misdistribution of Benefits & Damage	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Cultural heritage	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Local Conflict of Interests	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Water Usage & Rights	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Sanitation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Accident	C	C	C	C	C	C	C	C	C	C	C	C	C	C	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	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Natural Environment	Geographical Feature	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Soil Erosion	C	C	C	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Ground Water	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Coastal Zone	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Fauna, Flora, Biodiversity	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Meteorology	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Landscape	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Global Warming	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Pollution	Air Pollution	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Water Pollution	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C
	Soil Contamination	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Solid Waste	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Noise and Vibration	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C	E	E	E	E	E	E	E	E	E
	Ground Subsidence	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C	E	E	E	E	E	E	E	E	E
	Offensive Odour	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	Bottom Sediment	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

Source: JICA Project Team

Table 14.2.12 Ratings of Predicted Impacts- Waste Management & Social Services

IMPACTS		A: Serious adverse impacts are expected. B: Some adverse impacts are expected C: Extent of impact is unknown at this stage. D: Positive impact is expected E: No adverse impact is expected									
		Waste Management				Social Services					
		WM – 1	WM - 2	WM – 3	WM - 4	SS – 1	SS - 2	SS - 3	SS - 4	SS - 5	SS - 6
Social Environment	Involuntary settlement	E	E	E	E	E	E	E	E	E	C
	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	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	Air pollution	E	E	E	E	E	E	E	E	E	E
	Water Pollution	C	C	E	C	C	C	C	C	C	C
	Soil Contamination	C	C	E	C	C	C	C	C	C	C
	Solid Waste	E	E	E	E	C	E	E	E	E	E
	Noise & Vibration	C	C	E	C	C	C	C	C	C	C
	Ground Subsidence	E	E	E	E	E	E	E	E	E	E
	Offensive Odour	C	C	E	C	C	C	C	C	C	C
	Bottom Sediment	E	E	E	E	E	E	E	E	E	E

Source: JICA Project Team

14.2.3 **Positive and Negative Ratings Analysis**

Table 14.2.13 Outline of Predicted Impact

Category	Impact	Rating	Description
Social Environment	Involuntary Resettlement	B	Much of the proposed projects for development are to take place on customary owned land though there are some proposed to take place on State Land. The extent to which the Project intervention will impact on the landowners and communities is difficult to state but can be determined through appropriate ground truthing by undertaking household survey to determine the affected people to be duly and appropriately resettled if need be and or appropriately compensated. This is an exercise that will be strategically and diligently undertaken with proper planning in advance and ensuring compliance with the relevant laws involving appropriate responsible state agencies and specialists.
	Local Economy, Employment Livelihood	D	Economic development and provision of social services underpin the proposed projects for development with potential to have direct implication on growing local economy and improving the overall lives of people and communities through employment opportunities and business activities. Where appropriately qualified / experienced job opportunities will be offered to locals and members of communities.
	Land Use, Utilization of Local Resources	D	The extent to the use of the land needs to be determined but much of the proposed major industrial development projects are focused on facilitating use of the enormous local resources in food processing business activities. Appropriate approvals will be duly sought for use of local resources should need arise.
	Local Community	C	The proposed Project for development that require customary/community land will have a lot of implications on the people both positively and negatively. The potential for positive impact on the communities' are enormous provided they are appropriately assisted to actively participate and also put their land resources to good use following EFPIC process. Communities' rights will also be observed and respected at all times.
	Existing Social Infrastructures & Services	C	Potential for positive trickle on effects onto the existing social services are great without a doubt and contribute enormously to improving provision of social services to the people. However the extent to how much this positive impact will be realised is difficult to say with certainty. Likewise can be said for any potential negative impact without undertaking a closer examination and assessment of the likely implications.
	The Poor, Indigenous & Ethnic People	C	The extent to any positive or negative impact is again difficult to state with certainty without undertaking rigorous assessment, analysis and determination but the proposed projects focus on improving social services and providing opportunities for people to become actively involved in any potential business and commerce activities that may arise as a result, the opportunities are good..
	Misdistribution of Benefits and Damage	C	This is difficult to state with confidence as such issues/challenge will no doubt differ from Project to Project and community to community but this is an administrative matter that falls under the jurisdictions of the Government and the other appropriate authorities to deal with.

Category	Impact	Rating	Description
	Cultural Heritage	E	Culture is not static and is subject to change through the course of time and generations. There is no question to the value placed on individual cultural heritage that is respected and celebrated despite hundreds of years of outside influence. The proposed Project development will have impact on the lives of the many traditional communities but its cumulative impact is negligible considering the change influence that the people and communities have been subjected thus far.
	Local Conflict of Interests	C	This challenge will no doubt differ from place to place and Project to Project and is difficult to state with certainty without undertaking any specific assessment. Again, any such matters arising will be appropriately dealt with by the Government and its responsible agencies.
	Water Usage Rights	E	All water use rights belong to the State although the State does recognize the user rights of communities where appropriate compensation payments are allowed for. Any use of water resources requires seeking approval and acquiring user permits from the Water PNG Authority besides seeking community consent.
	Sanitation	E	Likewise as the requirements for water use rights, appropriate sanitation requirements require Health Department approval hence, there is no serious issue of concern in a big way.
	Accidents	E	In all major Project development or business activities, there are Health and Safety standards that apply in order to mitigate or minimise accidents. Accident is accident and is unpredictable hence, due precautions have to taken by ensuring full compliance with the safety standards.
	Infectious Diseases such as HIV AIDS	C	Effective education and awareness, and information dissemination are the most effective ways to mitigate or minimize potential major impact by applying health and safety practices. Any success is as good as a well informed citizen or people but again.
Natural Environment	Geographical Features	E	Much of any proposed Project development is on areas that are already altered/changed, and therefore there would be limited direct alteration to the natural geographical setting of any one area. Exception would be construction of the bypass access road connecting Yalu and Igam Barracks but this would be minimum at the most if there is going to be any induced change.
	Soil Erosion	E	There will be loss of soil in any Project development but this can be minimized or mitigated applying technically appropriate measurers in design and during implementation. Overall there would be minimum to nil loss of any significance.
	Ground Water	E	There will be limited impact of any serious concern.
	Flora, Fauna, Biodiversity	E	There will be no serious loss of any fauna and flora as a result of the proposed Project development. Much of the areas proposed for development under the projects will take place in areas that are already severely altered. By exercise caution and applying appropriate mitigation measures can certainly contribute towards safeguarding and protecting any species or habitats are of value needing protection.
	Meteorology	E	Pretty limited direct impact of any sort from the proposed Project development.

Category	Impact	Rating	Description
	Landscape	E	As with the geographical features there will be limited impacts of any sort to the landscape. Should there be any major change/alterations, rehabilitation process apply to be consistent with the Environment Act 2000.
	Global Warming	E	Again it would be negligible in the immediate short term but would be of concern in the long run, especially with industry development thus, require careful allowance in ensuring effective mitigation measures put in place in the overall design and development of the proposed projects development. Overall any impact would be minimal to none.
Pollution	Air Pollution	E	Similarly as above but caution needs to be taken in ensuring effective mitigation and minimization of air pollution over time.
	Water Pollution	E	It would be negligible provided that effective mitigation measures are put in place to ensure compliance with standard practices of pollution containment and consistent monitoring.
	Soil Contamination	E	Soil pollution as an issue again, would be minimal and of no serious concern provided there is effective control measures to mitigate any adverse impact. It is negligible.
	Solid Waste	E	It is always a standard practice to ensure proper disposal of solid waste and this is provided for in the Environment Act 2000. Ensuring compliance can minimize any adverse impact, otherwise it is of no serious issue of concern.
	Noise & Vibration	E	Noise and Vibration become issue of concern during Project development but these are manageable as per the requirements under the Environment Act 2000.
	Ground Subsidence	C	Ground subsidence issues really becomes a concern in road construction especially in the proposed Yalu-Igam bypass access road, otherwise, the other proposed Project pose no real danger to the issue of land subsidence. Any exception would be from natural occurrence due to the natural unstable geology of the area which Lae is naturally subjected to. To such threats are always factored into the over Project design and construction.
	Offensive Odour	E	There are standard procedures applied to mitigate or minimize any odour effect if any during construction.
	Bottom Sediment	E	There will be limited or nil impact on bottom sediment of any kind. Standard practices will be applied to proper treatment before disposing of any material of concern.

Source: JICA Project Team

14.2.4 **Mitigation and Monitoring**

Proposed mitigation and monitoring measures for key impacts as shown in Table 14.2.14 .

Table 14.2.14 Proposed Mitigation and Monitoring Measures

	Activities	Rate	Mitigation Measures	Monitoring Measures
Social Environment	Involuntary Resettlement	B	- Establishment of a community consultation coordination committee for mutually agreed land acquisition and meeting on the requirement for appropriate compensation conforming with the appropriate law and compensation requirements. - Undertake enumeration of households and houses - Holding of effective stakeholder consultation and facilitating information disclosure through information dissemination, and confirmation of agreement with stakeholders - Undertake mutually agreed Resettlement Action Plan	- Ensure compliance with the stakeholder consultation requirements under the PNG laws such Physical Planning Act 1989, and the environment Act 2000 - Comply with the Stakeholder Consultation Action Plan (SCAP) and the Scheduled Consultation as encapsulated in the matrix of consultation activities - Ensure appropriate compensations are paid accordingly and in good time - Hold stakeholder consultation meetings as scheduled
	Local Economy, Livelihood	D	- Undertake household survey to establish a structured information base on such as jobs and income - Facilitate and establish administrative mechanisms for provision of equal job opportunities of affected communities	- Maintain a sound database of employment opportunities and jobs created - Business opportunities and its contribution to the economy overall - Assess improvements overall accrued to livelihood
	Land Use & Utilization of Local Resources	C	- Provide technically appropriate cadastral・topographical map of the area covering and showing existing land area, suitable agricultural land, settlements - Apply technical diligence in Project activity design to avoid conflicts in development plans with existing settlement structures - Ensure adequate allowance is given in Project design for “green zones”, including preservation and conservation of existing natural setting and landscape	- Ensure Project designs allow for appropriate land use applying principles of sustainability - Allow for provision of “Green Zones” - Ensure compliance with the established monitoring protocols
	Existing Social Infrastructures & Services	C	- Undertake survey and appropriately enumerate existing social infrastructures in the target areas such as schools, hospitals/clinics, churches, water pipe line - Provide advance notification/announcement through appropriate media outlets on Project construction/development intervention - Undertake stakeholder meetings as means to information dissemination, awareness and education	- Ensure compliance and adherence to Project design plans and delivery of the required infrastructure output - Ensure provisions of safety of workers and residents during Project implementation
	Water Usage & Rights	C	- Undertake stakeholder consultation and disseminate information, awareness and education on Project activity intervention.	- Maintain adequate and appropriate education/awareness through stakeholder consultation and

	Activities	Rate	Mitigation Measures	Monitoring Measures
			- Engage Water PNG to provide advice and guidance on water use and use rights	information dissemination
	Sanitation	E	- Installation of appropriate but temporary toilet facilities for Project staff	- Maintenance of good hygiene and cleanliness - Ensure compliance hygiene rules
	Accidents	C	- Provide advance notification, education/awareness information dissemination - Apply specifically developed work safety education and awareness program for both Project staff and affected communities, including collaboration with the traffic police - Apply traffic control during construction, including installation of appropriate traffic control signs	- Maintenance of safety requirements at all times by ensuring compliance with established monitoring protocols during construction
	Infectious Diseases such as HIV AIDS	C	- Provide appropriately developed safety, healthcare education information on infectious diseases both for the affected communities and the workers - Undertake periodic prevention education awareness/education campaigns	- Ensure compliance with safety standards as conditions of engagement in workplace - Provide periodic awareness and education for all on health care and safe conduct
Natural Environment	Soil Erosion	E	- Apply technically accepted construction standards and guidelines for erosion mitigation during constructions such as setting up slope protection measurers	- Ensure compliance with mitigation measures to prevent soil erosions
	Ground Water	C	- Seek advice and input from Health and Water Authorities on the requirements of toilet construction and waste disposal to safeguard ground water quality	- Apply preventative measures to mitigate/avoid ground water contamination through appropriate waste disposal system
	Coastal Zone	E	- Undertake seashore/marine survey to have a understanding of the marine environment and apply appropriate mitigation measures during construction - Where necessary, undertake survey and compile species list to determine potential species vulnerable to construction induced impacts. - Select and apply appropriate technical wharf design for construction - Undertake appropriate mitigation measures to avoid coastal and undersea pollution	- Apply appropriate Project activity design to mitigate and prevent any harm to the coastal zone and environment, and provide protection to ecosystem and species - Undertake consistent monitoring to ensure compliance with established mitigation standard requirements
	Flora, Fauna, Biodiversity	E	- Undertake appropriate biological survey where necessary to compile species list to determine any species that may be vulnerable to the Project measures to provide appropriate mitigations - Apply technically specific design to Project construction with minimal implications on the environment /	- Apply appropriate Project activity design to mitigate and prevent any harm to both the terrestrial and marine environment, and provide protection to ecosystem and species.

	Activities	Rate	Mitigation Measures	Monitoring Measures
			species. - Incorporate natural environment setting within the development design and construction as part and parcel of "green zone" or conservation areas as part of the Project development design - Minimize tree felling	
Pollution	Air Pollution	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate air pollution	- Ensure compliance with the established mitigation protocols by consistent monitoring
	Water Pollution	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate water pollution	- Ensure compliance with the established mitigation protocols by consistent monitoring
	Soil Contamination	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate any soil contamination	- Ensure compliance with the established mitigation protocols by consistent monitoring
	Solid Waste	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate solid waste production and ensure appropriate disposal	- Ensure compliance with the established mitigation protocols by consistent monitoring
	Noise & Vibration	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate/minimize noise and vibration	- Ensure compliance with the established mitigation protocols by consistent monitoring
	Offensive Odour	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate or minimize any offensive odour	- Ensure compliance with the established mitigation protocols by consistent monitoring
	Bottom Sediment	E	- Apply appropriate measures that can be included within the Project design and construction plan to mitigate any excessive sediment discharge	- Ensure compliance with the established mitigation protocols by consistent monitoring

Source: JICA Project Team

14.3 Stakeholder Engagement

This section provides a brief narrative on the Stakeholder Engagement component of the Lae – Nadzab Urban Development Project describing the tasks undertaken as per the Project requirement and the proposed engagement mechanism to facilitate consultation and communication to meet the stakeholder call for an effective consultation, communication, and engagement into the future of the Project implementation.

Stakeholder consultation and engagement is a prerequisite as per the Lae-Nadzab Urban Development Plan (LNUDP) Agreement, and under the requirements of the JICA Guidelines for Environment and Social Considerations of June 2010. It is also a mandatory requirement under the respective legislations of the Papua New Guinea Department of Lands and Physical Planning (DLPP) and the Conservation Environment Protection Authority (CEPA).

In order to comply with the provisions of both the internal and external stakeholder engagement requirements, the JICA Project Team has duly incorporated the stakeholder consultation and engagement activities within the overall framework of the current Project implementation schedule. It has been engaging with the relevant Project stakeholders at the onset of the Project implementation in March of 2015, and is committed to continuing this engagement through all stages of the Project identification phase and the LNUD Project. The objectives of stakeholder consultation for the LNUDP are:

- To provide opportunity for the participation and input of the stakeholders such as the landowners/communities, government bureaucrats and politicians, and the business communities;
- To participate in the Lae-Nadzab urban structure and zoning plan identification;
- Showcase the list of the potential projects and the concepts plans developed, including criteria, rationale and justifications used and applied;
- Disseminate information about the LNUDP Project, especially the individual potential projects for the stakeholder consideration, valuation and assessment, and feedback;
- To maintain engagement and openly attend to any pertinent issues of concern and expectations, and seek amicably acceptable resolutions in order to minimize potential for misunderstandings to occur;
- To maintain good understanding, dialogue, and build positive relationship with key stakeholders; and
- Affirm Project Team and partners' commitment to active engagement with the stakeholders in the Project development.

During the Project identification phase of the LNUDP Project stakeholder engagements and consultations was limited to:

- One on One consultation engagement
- Joint Coordinating Committee Meetings
- Working Group Meetings
- Public Consultation Meetings
- Workshop Presentation of Project Progress Report
- Media and Project website

It should be noted that there has been overwhelming stakeholder consensus, both at the Project oversight and the Public Consultation meetings, calling for establishment of an effective stakeholder consultation mechanism to enable encompassing, inclusive, and meaningful engagement. The Project Team has duly noted the stakeholder call and is committed to developing the consultation mechanism and process that will become an inherent component of the LNUDP Project which is further describe below. The following brief narrative provides information on:

- the regulatory requirements for stakeholder engagement;
- the Project stakeholder engagement efforts; and
- a proposition for a stakeholder engagement mechanism

14.3.1 **Regulatory Framework**

There are a host of internal and external requirements that guide meeting the mandatory requirements for stakeholder engagement and this include:

- PNG Legislation, including the Constitution, the Environment Act 2000 and the Land and Physical Planning Act 1989,
- IFC PS, specifically PS 1, 2, 5, 6, 7, and 8; and

JICA Guidelines requirements 2010

14.3.2 **PNG Legislation and Regulations**

Table 14.3.1 provides an overview of the national legislation and regulations relevant to stakeholder engagement.

Table 14.3.1 Legislation and Regulations Applicable to Stakeholder Engagement

Act or regulation	Obligation or Requirement
PNG Constitution	The Constitution of PNG's National Goal 2, "Equality and Participation, aims for "all citizens to have an equal opportunity to participate in, and benefit from, the development" of PNG. The Directive Principles of National Goal 2, applicable to stakeholder engagement and communication, are as follows: • (1) equal opportunity for every citizen to take part in the political, economic, social, religious and cultural life of the country; • (5) equal participation by women citizens in all political, economic, social and religious activities; • (6) maximisation of the number of citizens participating in every aspect of development • (9) every citizen to be able to participate, either directly or through a representative, in the consideration of any matter affecting his interests or the interests of his community. The Constitution additionally sets out that all PNG citizens have the basic social obligations to themselves, their descendants, to each other and to the nation, to: • Recognise that they can fully develop their capabilities and advance their true interests only by active participation in the development of the national community as a whole; • Exercise the rights set out in the Constitution and to use the opportunities made available to them to participate fully in the government of the nation; • Protect PNG and to safeguard the national wealth, resources and environment in the interest of s not only of the present generations but also of the future generations; and • Respect the rights and freedoms of others, and to cooperate fully with others in the interests of interdependence and solidarity
Environment Act 2000	One of the objectives of this Act (object i) is to regulate activities which may have a harmful effect on the environment in an open and transparent manner, and ensure that consultation occurs in relation decisions taken under this Act with persons and bodies who are likely to be affected by them, Section 5 of this Act recognises, as a matter of national importance, the role of landowners' decision – making about the development of the resources on their land. Section 6 of this Act states that the PNG environment is to be protected through a process of setting environmental objectives, which is to be achieved by; • Determining environmental objectives by researching the state of the environment and identifying the beneficial values which are important to the community and which require protection from environmental harm, through a process of consultation; and • Requiring proposed activities involving matters of national importance to undergo a process of public and detailed consideration of environmental impact assessment. Section 55 recognises public consultation as part of the state's EIA process, and requires a period of public review of the EIS
Physical Planning Act	Sections 59, 60, 64, 66, 67, and 68 of the Physical Planning Act 1989 allows for public display and input (comments) into Physical Planning Areas, including Gazettal of a declared Physical Planning Area signify the importance of public participation.

Source: JICA Project Team

14.3.3 **IFC PS Performance Standards and Policies**

The following IFC PS (2012) applies to Stakeholder engagement:

- IFC PS 1: Assessment and Management of Environment and Social Risks and Impacts , which establishes the importance of effective community engagement through disclosure of Project –

related information and consultation with local community on matters that directly affect them;

- IFC PS 2: Labour and Working Conditions, which requires proponents to develop and make easily accessible a grievance mechanism for workers and their organizations (where applicable) to raise reasonable workplace concerns;
- IFC PS 5: Land Acquisition and Involuntary Resettlement, which requires consultation for matters of land acquisition and involuntary resettlement that evidence the informed participation of affected persons and communities in decision-making processes. It also requires that proponents establish special grievance mechanism to receive and address concerns specific to compensation and resettlement;
- IFC PS 7: Indigenous Peoples, seeks to establish and maintain an ongoing relationship with Project-affected Indigenous People that is based on Informed Consultation and participation (ICP). It also seeks to ensure the Free Prior Informed Consent (FPIC) of the affected communities of Indigenous Peoples on certain matters that affect them directly; and
- IFC PS 8: Cultural heritage, which requires consultation with affected communities who use, or have used within living memories, any Project-affected cultural heritage for longstanding cultural purposes, and the incorporation of the affected communities' views on such cultural heritage into the Project's decision-making process. Consultation will also involve the relevant national or local regulatory agencies that are entrusted with the protection of cultural heritage.

The following IFC Policies apply to stakeholder engagement and communications:

- IFC Policy on Environmental and Social Sustainability, 2012, which highlights the need for community engagement and broad community support, specifically stating "*IFC expects clients to engage in a process of ICP …. And enables the participation of the Affected Communities, leading to Broad Community Support for the participation of the Affected Communities…*". Broad community support is defined by IFC as a "*collection of expressions by the Affected Communities, through individuals or their recognised representatives, in support of the Project"*.
- IFC policy on Environmental and Social Sustainability, 2013, where a proposed business activity triggers the PS 7 requirements of FPIC of Indigenous peoples, IFC will undertake an in-depth review of the process conducted by the client as part of its environmental and social due diligence

14.3.4 **JICA Guidelines 2010**

The JICA Guidelines for Environmental and Social Consideration Guidelines of April 2010 provides the performance Principles that guides undertaking of environmental and social considerations in ODA Project development. JICA considers the following principles to be important that have to be met and they are;

(1) A "wide range" of impact must be assessed

The types of impacts addressed by JICA cover a wide range of environmental and social issues.

(2) Measures related to Environmental and Social Considerations must be implemented "from an early stage through to the monitoring stage"

JICA applies a Strategic Environmental Assessment (SEA) when conducting master plan studies etc., and encourages Project proponents etc. to ensure environmental and social considerations from an early stage to a monitoring stage.

(3) JICA is responsible for "accountability" when implementing cooperation projects

JICA ensures accountability and transparency when implementing cooperation projects.

(4) JICA asks "stakeholders" for their participation

JICA incorporates stakeholder opinions into decision-making processes regarding environmental

and social considerations by ensuring the meaningful participation of stakeholders in order to have consideration for environmental and social factors and to reach a consensus accordingly. JICA replies to stakeholders' questions. Stakeholders who participate in meetings are responsible for what they say.

(5) JICA "discloses information"

JICA itself discloses information on environmental and social considerations in collaboration with Project proponents etc., in order to ensure accountability and to promote the participation of various stakeholders.

(6) JICA enhances "organizational capacity"

JICA makes efforts to enhance the comprehensive capacity of organizations and operations in order for Project proponents etc., to have consideration for environmental and social factors, appropriately and effectively, at all times.

(7) JICA makes serious attempts at "promptness"

JICA addresses request of acceleration for the prompt implementation of projects while undertaking environmental and social considerations.

14.3.5 **Community Expectations**

The projects 'social license to operate' is defined by the expectations of the community regarding social and environmental stewardship. Failure to meet these expectations may result in;

- Damage to company and the Project Team's reputation through community action opposed to the Project;
- Loss of stakeholder support;
- Restrictions on/delays to Project Team and company's future operations or Project approvals; and
- Criticisms or poor community engagement in the media.

Community expectations will continue to be identified through the Project. The outcomes will be used to monitor and inform the Project Team engagement activities.

14.3.6 **Stakeholder Engagement**

The Project Team began engaging with the Government of Papua New Guinea, the Lae Urban Local Level Government, and the Morobe Provincial Government that led to the signing of the bilateral agreement between the Governments of Japan and Papua New Guinea in 2014. Since then, the Project Team has engaged with the relevant national government agencies, the Morobe Provincial Government, the Lae Urban Local Level Government, elected leaders of the Morobe Province, and the communities through their respective District Administrators and their LLG representatives.

On conclusion of the contracting agreement between JICA and Yachio Engineering Company Limited to undertake Project identification leg of the LNUDP Project, began the stakeholder engagement process. Stakeholder engagement is an integrated component of the Project and the activities to be undertaken are duly scheduled as an inherent part of the Project implementation schedule beginning April 2015 for the duration of the one year Project life. Details of stakeholder engagement/consultation are provided in Table 14.3.2

The engagement activities have largely focused on:

- Informing and educating stakeholders about the Project;
- Making opinions to determine future urban structure and zoning;
- Proactively catering for stakeholder issues and concerns;
- Collect required technical information, policies, laws, and baseline data for the respective components of the Project planning and design;

- Providing opportunities for stakeholder input into potential Project identification and planning process;
- Collecting baseline data to feed into the Project design, planning and impact assessment; and
- Identifying landowners and communities that will be affected by the Project.

14.3.7 **Levels of Stakeholder Engagement**

Table 14.3.2 Stakeholder Engagement undertaken by the Project Team

Stakeholder	Date	Activity	Purpose
Department of Lands and Physical Planning (DLPP)	June 2015 - 2016	Held one on one consultation as a Project Team or as individual consultants with the Chief Physical Planner and his staff during the course of the Project implementation.	▪ Provided overview and copy of the Project description ▪ Sought advice/input on DLPP technical and legal requirements on the Project as a physical planning area
Department of Transport (DOT)	June 2015 - 2016	Held one on one consultation as a Project Team or as individual consultants with the Secretary and the Deputy Secretary during the course of the Project implementation.	▪ Provided overview and copy of the Project description ▪ Discuss role and functions of JCC and DoT membership ▪ Sought technical input/advice on the specific Project activities specific to road and sea transport
Department of National Planning & Monitoring (DNP&M)	June 2015 - 2016	Held one on one consultation as a Project Team or as individual consultants with the Assistant Secretary for the bilateral Division during the course of the Project implementation.	▪ Provided overview and copy of the Project description ▪ Update on progress ▪ Briefing on JCC membership and matters relating JCC agenda
Department of Agriculture and Livestock (DAL)	June 2015 - 2016	Held one on one consultation as a Project Team or as individual consultants with the agricultural projects and land use division during the course of the Project implementation.	▪ Provided overview and copy of the Project description ▪ Update on progress
Conservation Environment Protection Authority (CEPA)	June 2015 - 2016	Held one on one consultation as a Project Team or as individual consultants with the Managing Director and Technical advisors on Environment Division during the course of the Project implementation.	▪ Provided overview and copy of the Project description ▪ Discuss role and function of JCC and CEPA membership ▪ Sought technical information advice on Environmental Assessment
Department of Works (DoW)	June 2015 - 2016	Held one on one consultation as a Project Team or as individual consultants with the Road works engineering supervisor during the course of the Project implementation.	▪ Provided overview and copy of the Project description ▪ Discuss role and functions of JCC and membership ▪ Sought technical and legal requirements on standards and policies
National Fisheries Authorities (NFA)	June 2015 April 2016	Held one to one consultation with the Fisheries Project Division representatives on fisheries industry and proposed Wagan Fisheries Project, Lae.	▪ Provided brief on potential industrial development prospects in the Project ▪ Sought information on proposed Wagan Fisheries development
Department of Labour & Employment	June 2015	Held one to one consultation with Labour and Employment Division to seek information assistance.	▪ Sought statistical data/information pertaining to labour and employment

Stakeholder	Date	Activity	Purpose
Department of Commerce, Trade & Industry	June 2015 - 2016	Held one to one consultation with the Secretary and industry division to seek information assistance on industry development.	▪ Provided overview and copy of the Project description ▪ Sought technical and policy information pertaining to Government to industrial development ▪ Sought the Dept membership on JCC
Office of National Statistics	June 2015 - 2016	Held one to one consultation with the Director and technical staff to seek data and information assistance on census and socio-economic development data for the Project site.	▪ Provided overview and copy of the Project description ▪ Sought socio-economic/demographics data on the Project Area
PNG Water	June 2015 - 2016	Held one to one consultation with the Momase Regional Manager and technical staff to seek data and information assistance on water resource, quality supply, consumer data and sewerage.	▪ Provided overview and copy of the Project description ▪ Sought technical information water supply, sewerage, waste treatment
Forest Research Institute (FRI)	August 2015	Held one to one consultation on forestry, vegetation and environment of the Project site.	▪ Sought technical information on vegetation and flora of the Project Area.
Department of Police	June 2015 - 2016	Held one to one consultation on social service relating to information assistance on police and social service infrastructure construction and development.	▪ Provided overview and copy of the Project description ▪ Police infrastructure standards
Department of Education	January-March 2016	Held one to one consultation on social service relating to information assistance on education and social services infrastructure construction and development standards requirements.	▪ Provided overview and copy of the Project description ▪ Education infrastructure standards
Department of Health	January-March 2016	Held one to one consultation on social service relating to information assistance on health and social services infrastructure construction and development standards requirements.	▪ Provided overview and copy of the Project description ▪ Health infrastructure standards
Malahang Industry	June 2015 - 2016	One to one consultation on social service relating to information assistance on industrial policy and development requirement, business and economics at Malahang and Lae.	▪ Provided overview and copy of the Project description ▪ Industrial development and infrastructure matters
JICA PNG Office	June 2015 - 2016	One to one consultation on Project implementation and progress	▪ Provided overview and copy of the Project document ▪ Sought input and advice on the aspects of the Project design, planning and implementation ▪ Sought assistance on stakeholder appointments
Asian Development Bank	June 2015	One to one consultation on the Project development, experience exchange and advice and sought insight into future plans in Lae.	▪ Provided overview and copy of the Project description Sought expertise input and advice pertaining to Project development and challenges specific PNG.

Stakeholder	Date	Activity	Purpose
World Bank	May-June 2015	One to one consultation on the Project development, experience exchange and advice and sought insight into future plans in Lae.	▪ Provided overview and copy of the Project description ▪ Sought expertise input and advice pertaining to Project development and challenges specific PNG.
Investment Promotion Authority (IPA)	July 2015	Held one to one consultation with trade and investment division to seek information assistance on business, commerce and industry development.	▪ Provided brief overview and copy of the Project document ▪ Sought data on investment PNG economy ▪ Sought specific businesses addresses and contact persons information pertinent to LNUDP
Institute of National Affairs (INA)	June 2015	Held one to one consultation with trade and investment division to seek information assistance on business, commerce and industry development from the Private Sector perspective.	▪ Provided brief overview and copy of the Project document ▪ Sought expertise input / advice on business investment and economic development climate
Morobe Provincial Government (Administration)	June 2015 – 2016	Constant and continuing coordination, dialogue, liaison, and communication consultation on the Project implementation	• Overall Project administration, management, technical assistance, advice, consultation and coordination as Project partners
Lae Urban Local Level Government	June 2015 – 2016	Constant and continuing coordination, dialogue, liaison, and communication consultation on the Project implementation	• Overall Project administration, management, technical assistance, advice, consultation and coordination as Project partners
Lae Chamber of Commerce and Industry	June 2015 – 2016	Held one on one consultation on the Project development	▪ Provided brief Project overview and copy of the Project document • Sought expertise input / advice on business investment and economic development climate

Source: JICA Project Team

In addition to the above the Project Team have a specific website (www.lnudp) where the Project activities are published and disseminated for wider interested stakeholder consumption, especially international audience aside from continuing occasional news publications in the print media, radio and the TV.

During the course of the current Project implementation stakeholder engagement and consultation has been undertaken at several levels and they are as follows:

- One on One Engagement

One on one engagement and consultation with the relevant institutional representatives involved gathering technical information/data, technical, policy and legislation, providing Project progress update through briefing and provision of draft Project report. The institutional representatives have become contact points for ongoing consultation as and when the need arise for the respective Project component specialists. Table 14.3.2 provides information the Project Team has engaged with on one on one basis.

- Joint Coordinating Committee (JCC)

JCC is the overall national oversight committee for the Project comprising of the different government institutional representatives as: the Department of Lands and Physical Planning, Department of Treasury, Department of National Planning and Monitoring, Department of Transport, Department of Agriculture and Livestock, Department of Works, Water PNG, PNG Power Limited, Department of Commerce Trade and Industry, Conservation Environment Protection Authority, and Lae Chamber of Commerce and Trade. A total of four JCC meeting is

scheduled for the Project duration. The recorded outcomes and minutes of the JCC meetings held are provided in Annex-3.

- Working Group (WG)

Working Group is Lae (Project site) based but a smaller group comprising of technical representatives from Lands and Physical Planning, PNG Water, PNG Power Ltd, Morobe Provincial Administration, Lae Urban Local Level Government that are called upon for consultation on technical matters relating to the Project design, plans and any pressing issues needing immediate attention as an when the needs arises.

Public Consultation (PC) Meetings

Public Consultation is a scheduled engagement and consultation with the stakeholders, but more specifically involving the customary landowners, and respective representatives from LLG, Districts, community leaders, including Morobe Provincial Administration where presentation on the Project design, concept plans, and suggested potential projects are presented for the stakeholder information awareness, input and feedback.

	
Speech by Provincial Administrator	Speech by Huon District Administrator
	
Speech by JICA PNG Chief Representative	Speech by Ms. Kouza, Lae MP
	
Presentation by Project Team Leader	Presentation by Project Expert (Industrial Dev.)

	
Participant Commenting during Discussion	Participant Commenting during Discussion

- Workshop Presentation (Project progress update)

  Workshop presentations are held specifically to make presentation to update the members of the JCC, WG, Politician and Government Department bureaucrats, and bilateral partners on the progress of the LNUDP execution against the Project implementation schedule.

The Table 14.3.2 presents the schedule of the different consultation engagements for the one year duration of the Project Identification period leading up to the completion of the documentation of the Master Plan.

For the duration of this Project identification leg of the LNUDP Project, the scheduled engagement and consultation meetings comprises of:

- Four Public Consultation (PC) Meetings
- Four Joint Coordinating Committee (JCC) Meetings
- Fifteen Working Group (WG) Meetings
- Four Workshops - Project Progress Report Presentation

At the writing of this section, so far two scheduled Public Consultation meetings have been successfully concluded with two more that remain to be held through the course of the current leg of the Project implementation. These consultations have been complimented by two JCC, twelve Working Group consultation meetings, including three Project Progress Report Presentations. In the second round of Project Progress Report Presentation in Lae, separate presentations were made specifically for the Morobe Provincial Government and the Private Sector.

14.3.8 **Stakeholder Issues**

During the stakeholder engagement activities, a number of issues were identified that were of particular interest or concern to various stakeholder groups. These are summarized in Table 14.3.3. These issues have fed into the overall Project design, concept planning, implementation, and impact assessment.

Table 14.3.3 Stakeholder Issues

Stakeholder group	Key Issues
Government	▪ Compliance with the legislative requirements of the respective Government Departments such as, Physical Planning, Environment Acts ▪ Ensuring effective consultation with the relevant government institutions ▪ Ensuring effective community consultation and participation ▪ Incorporating measures and actions to mitigate environmental and social impacts ▪ Varying Project interest for LNUDP ▪ Urban structure and zoning
Community	▪ Urban structure and zoning ▪ Need help to register landowner groups in order to participate in projects

Stakeholder group	Key Issues
	▪ Need transparent consultation and information on the Project to make informed decision ▪ Conscious about their land rights and ownership and appropriate compensation ▪ Expecting consideration and equal opportunities for women and youth employment ▪ Expectations of job employment
Private Sector	▪ Customary land issues ▪ Squatter Settlements ▪ Sound technical Urban planning- holistically ▪ Urban structure and zoning
Bilateral partners	▪ Customary landownership issues to be carefully attended to and effectively dealt with ▪ Improve on Project selection criteria, rationale, and justification
Multilateral Partners	▪ Customary landownership issues to be carefully attended to and effectively dealt with

Source: JICA Project Team

14.3.9 **Future Stakeholder Engagement**

The success of the LNUDP is very much dependent on the active engagement of the stakeholders and giving their consent. The JICA Project Team duly acknowledges the importance of active stakeholder participation in the Project, and the all too important landownership as a sensitive issue of concern, requiring maintaining an effective stakeholder consultation and dialogue hence, is and will be an important priority activity component of the LNUDP project during the projected 10 years of the planning period.

The Project Team is also very much conscious of the mandatory legislative and policy requirements of the specific laws of the country and JICA, especially fully meeting the requirements of the Free Prior Informed Consent (FPIC) requirements involving with the customary landowners.

There has also been unanimous undertaking (see consultation meeting records) in the many stakeholder consultations held thus far, at the technical level and with the public, for an effective consultation mechanism to be put in place as an inherent activity requirement of the Project. Accordingly, an undertaking to put in place a planned stakeholder consultation and engagement mechanism is on foot with a scheduled description of specific activities to be undertaken, at the onset of the LNUDP Project, and over the course of the duration of the specific Project activity development.

At this point in time awaiting the selection of a specific project, stakeholder mapping and engagement activities needs are envisaged to be the initial tasks to be undertaken should there be a need.

14.3.10 **Stakeholders Representation**

Presently, representatives from the Department Lands Physical Planning, Conservation Environment Protection Authority, Department of Treasury, Department of National Planning & Monitoring, Department of Transport, Department of Works, Water PNG Authority, PNG Power Limited, Lae City Council, Morobe Provincial Government, Department of Trade, Commerce and Industry, Department of Agriculture, Lae Chamber of Commerce and Industry, make up the Joint Coordinating Committee (JCC) with JICA and Project Team.

Depending on the specific Project that will be selected, it is anticipated that these JCC representatives will continue to remain part of the national oversight committee. Due consideration will no doubt be given to bringing onboard additional representative members from relevant organizations from within the Project Area to become actively involved.

Depending on the type of the Project selected for development, and its location, consideration will be given to additional membership to the Joint Coordinating Committee from groups such as:

- National government-bureaucrats and politicians
- Provincial/local level government-bureaucrats and elected officials;
- Community representatives and women groups;
- Customary land owning groups, ILG, and associations;
- Community service providers (e.g. health care workers, churches,);
- Business houses;
- NGO's and community based organizations

14.3.11 **Stakeholder Engagement Mechanism**

The Project Team duly recognises the need for an effective approach to stakeholder engagement and consultation as echoed by the stakeholders. The need for a strategically structured and process approach with action plan and activities to undertake stakeholder engagement and consultation is unanimous and duly noted, and the matter will be duly attended to through the course the current leg of the Project engagement.

In the Public Consultation meeting on 28th April, 2015, the Morobe Provincial Administration through the Administrator, Mr. Moat, made a commitment to the participants in ensuring that there is an effective stakeholder engagement mechanism put in place to ensure effective information dissemination, consultation and active participation of the stakeholders, especially the landowners and communities.

In concurrence with this commitment, the Project Team prefers to see establishment of a stakeholder engagement mechanism (SEM) prior to the conclusion of the current Project identification leg of the LNUDP Project is due**.**

In anticipation of the establishment of a SEM, the PT envisage a staged process to formalizing SEM establishment upon selection of a potential LNUDP Project through hosting of a workshop to undertake the following initial generic activities;

- The Project Team (PT) in consultation with the Morobe Provincial Government (MPG) and the Lae City Council (LCC) make undertaking and formalize establishment of Stakeholder Engagement Oversight Group (SEOG).
- Develop specific TOR for establishment and operations of the SEOG;
- Define roles, responsibility, operations, and functions of SEOG;
- Formalize composition and membership of SEOG;
- Develop a defined tasks specific for the SEOG with a preliminary implementation schedule
- Develop stakeholder mapping strategy to confirm stakeholders to be part of the Project and those in the peripheries of the immediate surroundings ;
- Explore community organising strategy for purpose of effective consultation, liaison, engagement between the communities and the Project;
- Define strategy for Project development information for dissemination

The Project Team attests to the critical importance of seeing SEM become a reality and that, as a process mechanism, is integrated into the overall Project development plan and is administratively operationalized under proper guidance and supervision of a Project Management Unit or such administrative body as the proposed SEOG. Thus, and equally important, that SEM administration unit, likewise, is duly established, appropriately resourced, and is administratively operational to undertake the important responsibility of overseeing effective stakeholder engagement, consultation and information dissemination as is expected and required by the stakeholders and donor partners.

Stakeholder Engagement is a technically specialist profession demanding specialist attention and engagement hence, this raises the question of technical capacity and capability requirements needing appropriate consideration during the course of the Project development considerations.

The Project Team recognizes that there will always be grievances and likewise there will be established process and procedure put in place to attend to this need.

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SCHEDULE 1 **Act. Sec. 42** **Reg. Sec. 3**	
Environment Act 2000	
LEVEL 2 ACTIVITIES	
Column 1. Category number	Column 2. Category of Activity
CATEGORY A	
1.1	Sub –Category 1: Petroleum Exploration Drilling of oil and gas wells.
	Sub –Category 2: Mineral Exploration and Mining
2.1	Any drilling programme at a defined prospect where the aggregate depth of all holes drilled is greater than 2,500 metres.
2.2	Mechanised mining on a Mining Lease issued under the *Mining Act 1992* involving non –chemical processing of no greater than 50,000 tonnes per annum.
2.3	Gravel extraction operating continuously for more than 6 months and involving the extraction of no greater than 10,000 tonnes per annum.
2.4	Quarrying involving the extraction of no greater than 100,000 tonnes per annum.
3.1	Sub –Category 3: Minor Forest Activities Activities carried out under a Timber Authority issued under the Forest Act.
CATEGORY B	
	Sub –Category 4: Manufacturing and chemical processes Sub –Category 4A: Manufacturing operation (predominantly physical operations and blending not involving significant chemical reaction)
4.1	Cement clinker manufacturing and grinding.
	Sub –Category 4B: Processes involving chemical reactions
4.2	Manufacturing of products by any chemical process in works designed to produce more than 100 tonnes per year of chemical products.
4.3	Manufacture of fibre –reinforced plastic (FRP) in works with a capacity of more than 50 tonnes per year.
4.4	Manufacture of acrylic compounds, fertilizers, herbicides, insecticides or pesticides by any chemical process.
4.5	Manufacturing operations involving the use of toluene di –isocyanate, methylene di –isocyanate, chlorofluorocarbons and halons.
	Sub –Category 5: Activities involving petroleum or chemicals
5.1	Manufacturing of organic chemicals requiring a Petroleum Processing Facility Licence issued under the *Oil and Gas Act 1998*.
5.2	Pipeline transport and storage and using facilities with a holding capacity of more than 0.5 million litres.
	Sub –Category 6: Forestry and production of timber products
6.1	Activities associated with a logging operation which are or should be undertaken under a timber permit or a licence, unless such licence holder is a subcontractor of a timber permit, (including sewage disposal, camp construction including power & water reticulation, operation of machinery workshops and construction of road and other infrastructure works including wharf and ship loading and unloading facilities).
6.2	Operation of stationary sawmills and treatment facilities with a production capacity of greater than 30,000 m3 per year of sawn timber.
6.3	Chemical treatment of timber using copper –chrome –arsenate solutions with a capacity of greater than 100 tonnes of treated wood product per year.
6.4	Processing of wood to form veneer, plywood, particleboard or fibre board.
6.5	Processing of wood, wood products, waste paper or other cellulose materials to form pulp, paper or cardboard.
	Sub –Category 7: Mining and extraction
7.1	Mechanised mining on a Mining Lease under the *Mining Act 1992* involving chemical processing of no greater

	than 50,000 tonnes per annum.
7.2	Mechanised mining on a Mining Lease issued under the *Mining Act 1992* involving non –chemical processing of more than 50,000 tonnes per annum.
7.3	Mineral beneficiations or processing other than alluvial mining in accordance with an Alluvial Mining Lease issued under the *Mining Act 1992*.
7.4	Quarrying involving the extraction of more than 100,000 tonnes per year.
7.5	Gravel extraction operating continuously for more than 6 months and involving the extraction of more than 10,000 tonnes per year.
7.6	Commercial salt harvesting.
	Sub –Category 8: Aquaculture and agriculture
8.1	Intensive animal industries including the raising of cattle, sheep, pigs, poultry and crocodiles with an annual production capacity of more than 200 animal units.
8.2	Operation of livestock holding pens with a capacity of more than 2,000 animal units per year.
8.3	Operation of aquaculture facilities with a design discharge flow rate greater than 1 per day or 100 tonnes of wet product per year.
8.4	Aquaculture carried out in “open sea” (cage) operations.
8.5	Agricultural cultivation of an area greater than 1,000 hectares.
	Sub –Category 9: Food processing and plant product processing
9.1	Processing of alcoholic and non-alcoholic beverages in a plant with a design production of more than 5,000 litres per day.
9.2	Operation of abattoirs and poultry processing facilities processing more than 200 animal units per year.
9.3	Processing coconut oil in plants producing more than 10,000 tonnes per year.
9.4	Processing of coffee or cocoa in plants producing more than 5,000 tonnes per year
9.5	Palm oil extraction and processing in plants producing more than 5,000 tonnes per year.
9.6	Seafood processing operations which involve the production of more than 500 tonnes per year.
9.7	Production of stock feed in mills producing more than 5000 tonnes per day.
9.8	Processing of latex and rubber in operations producing more than 500 tonnes per year.
9.9	Sugar refining operations with a production capacity of more than 5,000 tonnes per year.
	Sub –Category 10: Energy production
10.1	Operation of hydroelectric plants with a capacity of more than 2 Megawatts (MW).
10.2	Operation of fuel burning power stations with a capacity of more than 5MW, but not including emergency generations.
10.3	Operation of fuel burning appliances including furnaces and boilers with a rated thermal output of 20MW.
	Sub –Category 11: Waste treatment
11.1	Sewage treatment in plants serving more than an equivalent population of 5,000 people.
11.2	Septic tank sludge disposal systems intended to serve an equivalent population of greater than 500 people.
11.3	Operation of public and private landfills for the disposal of municipal waste, serving a population of more than 10,000 people.
11.4	Incineration, reprocessing, treatment or disposal of industrial or biomedical waste of a capacity greater than 10 tonnes per year.
11.5	Operation of rendering works with a capacity of greater than 500 tonnes per year.
11.6	Recycling waste material including but not limited to glass, oil, metal, paper and putrescible materials with a capacity greater than 100 tonnes per year.
11.7	Commercial drum reconditioning.
	Sub –Category 12: Infrastructure
12.1	Operation of maritime construction, deballast and repair facilities designed to handle vessels of a mass of greater than 50 tonnes.
12.2	Construction of marinas and boating facilities designed or used to provide moorings for more than 50 powered vessels at any one time.
12.3	Operation of potable water treatment plants wit a design capacity of greater than 1 million litres per day.
12.4	Construction of aerodromes or airfields except unpaved airstrips more than 10 km from an urban area.
12.5	Construction of new national roads.
12.6	Construction of electricity transmission lines or pipelines greater than 10 km in length.

12.7	Construction of housing estates with an area of more than 5 hectare.
	Sub –Category 13: Other activities
13.1	Damming or diversion of rivers or streams.
13.2	Discharge of waste into water or onto land in such a way that it results in the waste entering water, except where such discharge is ancillary or incidental to, or associated with, any other activity in this Regulation in which case that category of activity will apply to the discharge of waste.
13.3	Abstraction or use of water for commercial purposes, except where such abstraction or use is ancillary or incidental to, or associated with, any other activity in this Regulation in which case that category of activity will apply to the abstraction or use of water.
13.4	Import or export of ozone depleting substances or pesticides.

SCHEDULE 2
Act. Sec. 42
Reg. Sec. 4

ENVIRONMENT ACT 2000

LEVEL 3 ACTIVITIES

Column 1 Category number	**Column 2 Category of Activity**
	Sub –Category 14: General
14.1	Activities involving investment of a capital cost of more than K50 million, except where such investment is made in pursuing an activity otherwise dealt with in this Regulation in which case that category of activity will apply to the investment.
14.2	Activities involving the generation of a volume of liquid waste of more than 7,000,000 m3 per year (approximately 20 million litres per day).
14.3	Activities that will involve the discharge, emission or deposit of hazardous contaminants, except where such discharge, emission or deposit is ancillary or incidental to, or associated with, any other activity in this Regulation in which case that category of activity will apply to the discharge, emission or deposit.
14.4	Activities that may result in a significant risk of serious or material environmental harm within Wildlife Management Areas, Conservation Areas, National Parks and Protected Areas or any area declared to be protected under the provisions of an International Treaty to which Papua New Guinea is a party and which has been ratified by the Parliament of the Independent State of Papua New Guinea.
	Sub –Category 15: Manufacturing and processing
15.1	Activities involving investment of a capital cost of more than K20 million and which involve manufacturing or chemical processes not previously used in Papua New Guinea.
15.2	Manufacture of hazardous contaminants, except where such manufacture is ancillary or incidental to, or associated with, any other activity in this Regulation in which case that category of activity will apply to the manufacture.
	Sub –Category 16: Forest harvesting and land clearance
16.1	Logging operations where the minimum annual allowable cut is greater then 70,000 m3 per annum.
16.2	Any large scale clearing carried out under section 90(a), (b), (c) or (d) of the Forest Act.
	Sub –Category 17: Mining and extraction
17.1	Mining activities which require the issue of a Special Mining Lease under the *Mining Act 1992*.
17.2	Mechanised mining on a Mining Lease involving chemical processing, except where the activity falls within the ambit of a Category B, Level 2 activity.
17.3	Extraction of off –shore coral deposits for roading, commercial lime making or similar use.
17.4	Submarine tailings disposal.
	Sub –Category 18: Petroleum and gas production and processing
18.1	Recovery, processing, storage or transportation of petroleum products requiring the issue of a Petroleum Development Licence or a Pipeline Licence under the *Oil and Gas Act 1998.*
18.2	Refining of petroleum or manufacture and processing of petrochemicals or liquefaction of natural

	gas requiring a Petroleum Processing Facility Licence issued under the *Oil and Gas Act 1998* except where the activity falls within the ambit of a Category B, Level 2 activity.
	Sub –Category 19: Infrastructure construction
19.1	Construction of major hydropower schemes or water supply reservoirs inundating an area greater than 5 km2.
19.2	Construction of sea ports and ship repair facilities serving ships of an individual tonnage of more than 500 tonnes.
19.3	Infrastructure construction that requires the reclamation of more than 5 hectares of land below the high water mark.
19.4	Construction of sewage treatment plants designed to serve an equivalent population of greater than 50,000.
	Sub –Category 20: Fisheries
20.1	Aquaculture operations designed to discharge a volume of waste greater than 10 million litres per day.
	Sub –Category 21: Waste Disposal
21.1	Construction and operation of municipal landfills serving populations of more than 20,000 people.
21.2	Construction of commercial sites for the storage, treatment, reprocessing, incineration or disposal of hazardous contaminants.

CHAPTER 15 URBAN DEVELOPMENT PROGRAM AND PROJECT PROFILE

15.1 Project Programming Evaluation

15.1.1 Principle for Project Programming

Following principles for Project programming were established.

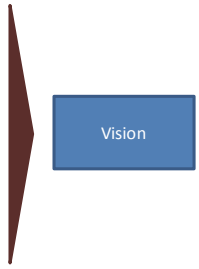
- Project program will be prepared based on the development strategies.
- Implementation stages are set for the periods of 2017, 2018-2020, 2021-2025, and 2026 and after.
- In case initial Project programming cannot be formulated due to budgetary constraints, the programme will be adjusted.
- Since budgetary frame is set based on the actual data in the past, it is greatly affected by the magnitude of foreign loan and grant elements. In estimating the future budgetary frame, it was assumed that such foreign loan and grant elements will keep present percentage of the total budget.

15.1.2 Adjustment Principles for Project Programme

Adjustment of the programme was applied in the following manner.

- Human capacity development as a base for the economic development is prioritized.
- Usually utility facilities such as water supply, sewerage, drainage and power supply are developed based on the road network, while road project as economic infrastructure will be prioritized among infrastructure projects.
- Project for disaster prevention to minimize large economic and human damages will be prioritized.
- Supply and disposal facilities projects that prevent large disruption to residents' life will be prioritized.
- Establishment of development method of customary land will be prioritized by studying ongoing Abongtu Land Development Project.

Urgent-term 2017	Short-term 2018-2020	Medium-term 2021-2025	Long-term 2026-2050
・ Prepae to implement Master Plan	・ Establish the base for urban development ・ Fostering growth/service centers	・ Implement master plan ・ Formation of growth/service centers	・ Implement master plan ・ Private secor gain momentum ・ Spillover effect of growth/service centers to the whole LN area
	・ Capacity developmment for ecnomic development	・ Formation of local industry	・ Formation of industrial cluster
・ Establishmnet of land development method by reviewing Abongtu Development ・ Institutional improvement for realization of MP	・ Industrial park development for SMEs ・ Road improvement to guide urban development ・ Implementation of urgent disaster prevention measures ・ Development of institutional facilities for capacity development for economic development ・ Improvement of land development method of customary land ・ Continuation of institutional improvement	・ Thrust of industrial park development ・ Thrust of land development ・ Development of urban utilities ・ Implementation of disaster prevention measures	・ Thrust of industrial park development ・ Thrust of land development ・ Implementation of disaster prevention measures ・ Enhancement of urban utilities ・ Park and Greenery development



Source: JICA Project Team

Figure 15.1.1 Development Stages for Project Programming

15.1.3 Estimate of Budgetary Framework for Master Plan

(1) Central and local government budgets

Actual governmental budgets are summarized below. After the review of those budgets governmental budgetary frame was estimated.

1) Central government's budget

Central government budgets in recent years are shown in Table 15.1.1. Total capital investment in fiscal year 2015 is PGK 4,270 million accounting for 17% of total budget amount.

Table 15.1.1 Central Government Budgets

(Unit: PGK million)

Budget Items		FY 2013	FY 2014	FY 2015	
		Actual	Budget (amended)	Budget	%
Income	Tax	8,599	9,744	11,257	57
	Non-tax	192	1,229	1,066	5
	Grants	611	1,684	1,384	7
	Borrowings	6,915	7,892	6,289	31
	Total	16,317	20,549	19,996	100
Expenditure	Personnel	3,099	3,093	3,841	15
	Other recurrent	5,748	7,238	6,960	28
	Capital	908	2,157	4,270	17
	Repayment	4,792	6,288	9,924	40
	Total	14,547	18,776	24,994	100
Balance		1,770	1,773	-4,998	

Source：National Budget

Capital budgets allocated from central government to departments, agencies and provinces are shown in Table 15.1.2. Allocated budgets for capital investment to relevant departments, agencies are highlighted in the table. In the total capital investment budget, funds from donors account for more than 30%. However, capital investment in the budgets of relevant sector shares more than 60% shown in the "Public Investment Programme 2016-2010".

Table 15.1.2 Capital Investment Budgets by Departments, Agencies and Provinces

(Unit: PGK million)

Departments/Agencies/Provinces		FY 2013	FY 2014	FY 2015			
		Actual	Budget (amended)	Budget	(%)	Budget for capital investment[1)]	(%)
National Departments (31) and Offices (38)	Agriculture & Livestock	23	43	73	0.3	20	0.5
	Lands & Physical Planning	60	62	59	0.2	14	0.3
	Transport	19	23	35	0.1	7	0.2
	Commerce & Industry	30	75	69	0.3	34	0.8
	Industrial Relations	16	27	35	0.1	2	0.1
	Works & Implementation	555	929	1,511	6.0	1,131	26.5
	Education	941	953	1,141	4.6	40	0.9
	Higher Education	71	78	283	1.1	119	2.8
	Health	423	752	614	2.5	19	0.5
	Other 60	5,311	6,833	6,444	25.8	1,178	27.6
	Debt Service Charges	4,792	6,288	9,924	39.7	-	-
	Total	10,806	14,280	20,188	80.8	2,545	59.6
Statutory Authorities (68)	Investment Promotion A.	3	3	4	0.0	-	0.0
	Small Business Dev. Corp.	3	3	4	0.0	0	0.0
	Industrial Centres Dev. Corp.	2	2	3	0.0	0	0.0
	Coastal Fisheries Dev. A.	21	42	28	0.1	18	0.4
	Cocoa Coconut Inst.	7	7	8	0.0	0	0.0
	PNG National Fisheries A.	0	0	20	0.1	10	0.2

Departments/Agencies/Provinces		FY2013	FY2014	FY 2015			
		Actual	Budget (amended)	Budget	(%)	Budget for capital investment[1)]	(%)
	Fresh Produce Dev. Comp.	6	6	12	0.0	0	0.0
	PNG Coffee Ind. Corp.	3	5	3	0.0	0	0.0
	PNG Oil Palm Ind. Corp.	27	10	0	0.0	0	0.0
	PNG Power Ltd.	7	19	117	0.5	89	2.1
	Other 58 Authorities	619	1,087	947	3.8	409	9.6
	Total	690	1,165	1,146	4.6	527	12.3
Provincial Government Grants (22)	Morobe Prov. Gov.	266	264	327	1.3	123	2.9
	Other 21 governments	2,785	3,066	3,334	13.3	1,076	25.2
	Total	3,051	3,330	3,661	14.6	1,199	28.1

Note： 1) Capital investment budgets are internal numbers of budget for FY2015.
Source：National Budget

2) Provincial government's budget

Budget of Morobe Provincial Government is shown in Table 15.1.3.
Provincial capital investment budget is PGK 176 million for FY 2015 highlighted in the table. This amount is duplicated with PGK 123 million, the central government budget to provincial government allocated to the provincial government. Therefore, provincial budget for the capital investment in 2015 from provincial own funding source is estimated at PGK 53 million. The figure was obtained as PGK 123 million subtracted from PGK 176 million.

Table 15.1.3 Morobe Provincial Government Budget

(Unit: PGK million)

Budget items		FY2013	FY2014	FY2015		FY2016	
		Actual	Actual	Budget	%	Budget	Ratio
Income	Tax	79	84	97	20	91	20
	Non-tax			22	5	21	5
	Grants	70	263	362	75	350	76
	Total	149	347	481	100	462	100
Expenditure	Personnel	18	93	179	37	180	39
	Other recurrent	63	60	79	16	89	19
	Grant to LLG	2	24	10	2	10	2
	Transport Infra. Maint.e. Grant	1	2	2	0	2	0
	District Services Improvement	2	90	90	19	90	20
	Province. Services Improvement	32	45	45	9	10	2
	Development	26	33	41	8	29	6
	Former years' appropriation	4	0	35	7	51	11
	Total	149	347	481	100	462	100

Note：Budget for 2016 is not yet approved as of March 2016.
Source："Budget Estimates", Morobe Provincial Government

3) Local Level Governments budgets

Local Level Governments budgets are shown in Table 15.1.4. LLG's capital investment budget seems solely of its own revenue. However, the budgetary amount is small.

Table 15.1.4 LLG's Budgets for FY2015

(Unit: PGK million)

Budget items		District G.	Local Level Government		
		Lae	Lae Urban	Ahi Rural	Wampar
Income	Recurrent	Not available	14.8	0.06	0.04
	Grant		2.6	1.3	1.1
	Total		17.4	1.4	1.1

Budget items		District G.	Local Level Government		
		Lae	Lae Urban	Ahi Rural	Wampar
Expenditure	Personnel	0.8	8.5		
	Other Recurrent	5.4	4.7	1.4	1.1
	Capital	8.3	4.2		
Total		14.5	17.4	1.4	1.1

Source：LLG's budget documents

(2) Estimate of Capital Investment Frame

Capital investment frame for LNUDP is estimated based on following conditions. Investment to the projects in master plan is possible.

1) Precondition

a) Estimate is based on the capital investment budget for 2015.

b) As the budget amount of provincial and local level governments are small, central government is assumed to shoulder most part of funding requirement for LNUDP.

c) As the LNUDP is focusing on the major promising development area in PNG, central government capital investment is preferably allocated to the LNUDP projects.

d) Capital investment is allocated to LNUDP in following rates.

Central government

1 to 5 % of capital investment budget is allocated to relevant departments including Works & Implementation, Education, Higher Education and Health.

Morobe Provincial Government

5% of own funding resource

Local Government

10% of capital investment budget

Budgetary frame of capital investment for LNUDP is estimated based on the above conditions shown in Table 15.1.5. Yearly budgetary frame for capital investment is some 20 to PGK 75 million, and total budgetary frame until 2025, the target year of LNUDP, is estimated at PGK 160 to 600 million.

Table 15.1.5 Estimated Budgetary Frame for Capital Investment for LNUDP

Government	Funding Capacity (PGK million)		Allocation Rate to Lae-Nadzab Area	Budget frame (PGK million)
Central government	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
Provincial government	Own funding resource	53	5%	2.6
Local level government	Own funding resource	12	10%	1.2
Total Budget				about20～75
Total budget of 8 years between 2018 to 2015				about 160～600

Source: JICA Project Team

(3) Project Cost of LNUDP M/P

Total estimated cost of 8 years between 2018 and 2025 is over PGK 2,400 million and some PGK 310 million on the yearly average. The Project cost is far beyond the capital investment budget

frame. The Project programming is reconsidered in an iterative way by the programming adjustment principle.

15.2 Project Program

Above Project cost is estimated on condition that all projects 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 that is an independent autonomous body outside the central government, construction costs of those facilities are finally borne by the users. Also in case of new urban development, sales/lease price of land shall be set to cover the total Project cost, so that Project cost can be repaid. Morobe Provincial Government can ask central government for subsidy in case of deficit in budget.

Other method to narrow the gap between Project cost and budget is to issue local bonds likewise in other country although such precedent examples in PNG are scarce. In PNG local government can apply the right of issuing local bond to the central government on the Project basis. In Morobe Province, Wagan Fishery Port Project can fall into this category.

From viewpoint above, projects in the Master Plan that are to be funded by the governments are confined to those projects within transport, flood control, and social service sectors. For instance, if the urban development includes construction of designated urban road to be implemented by the government, subsidy to the urban development by the government may be persuasive. In PNG, tax credit can be applied in an alternative way to alleviate the burden of the developer.

Total Project cost including projects in transport sector but excluding port development project, flood control sector, and social service sector and excluding those projects having revenues or incomes was estimated. 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 eight 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.

Of course, in case grant aid project by donor is offered, governmental budget burden would be alleviated.

Table 15.2.1 Defrayment of Project Cost

Sector	Implementing body	Assumed Income and Repayment of Project Cost	Remarks
Industrial Park	Central Gov., Prov. Gov., Private Sector, PNG Port Corporation	Project cost is to be covered by sales/lease price of land.	
Land Development (Housing)	Prov. Gov., Private Sector,	Project cost is to be covered by sales/lease price of land.	
Transport (road)	Central Gov., Prov. Gov.	Direct revenue from road users cannot be assumed. In principle, governments shoulder the Project cost. Indirect funding by car ownership tax or fuel tax can be applied to cover the Project cost. Construction cost of passages in new development area can be included in the sales/lease price of land.	Land acquisition of construction site is a prerequisite.
Transport (port)	Central Gov., Prov. Gov.	Mooring charge and berthing charge can be applied and those can cover Project cost.	
Transport (bridge)	Central Gov., Prov. Gov.	Passage fee can be applied to cover the Project costs	It is not easy to get people's consents of passage fee. .

Sector	Implementing body	Assumed Income and Repayment of Project Cost	Remarks
Flood control	Central Gov.	No income from flood control Project can be assumed.	
Water supply	Water PNG, Private sector, Provincial Gov.	Operation and management cost shall be covered by revenue of water supply. In case of new land development area, two type of funding source is presumed. One is Project cost to be included in the sales/ease price of land, the other is Project cost to be covered by governmental budget. As for the water purification plant, one alternative is that Project cost is covered by sales/lease price of land in newly developed area and tariff escalation in the existing servicing area, another alternative is to be funded by the government budget.	Water supply shall be implemented by the private sector or local government in case of urban development. However, after the completion of the urban development operation and management can be transferred to Water PNG.
Sewerage		Operation and management cost shall be covered by revenue of sewerage service. In case of new land development area, two type of funding source is presumed. One is Project cost to be included in the sales/ease price of land, the other is Project cost to be covered by governmental budget. As for the sewerage treatment plant, one alternative is that Project cost is covered by sales/lease price of land in newly developed area and tariff escalation in the existing servicing area, another alternative is to be funded by the government budget. In Lae City tariff level is too low to cover the sewerage plant construction cost, revision of tariff may be necessary.	Sewerage facilities shall be implemented by the private sector or local government in case of urban development. However, after the completion of the urban development operation and management can be transferred to Water PNG.
Solid Waste Management	LLG	Operation and management cost is not covered by revenue of sewerage service through LLG. In case of new construction of dumping site, there are two options, one is to be covered by the revenue from people, and the other is to be funded by the government.	
Social Service	Central Gov., Prov. Gov.	Governments bear in principle the Project cost.	Health facilities, schools, police boxes, parks are shouldered by government in principle. However due to lack of budget, there is a possibility for a delay of arranging those facilities.

Source: JICA Project Team

However it should be noted that 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.

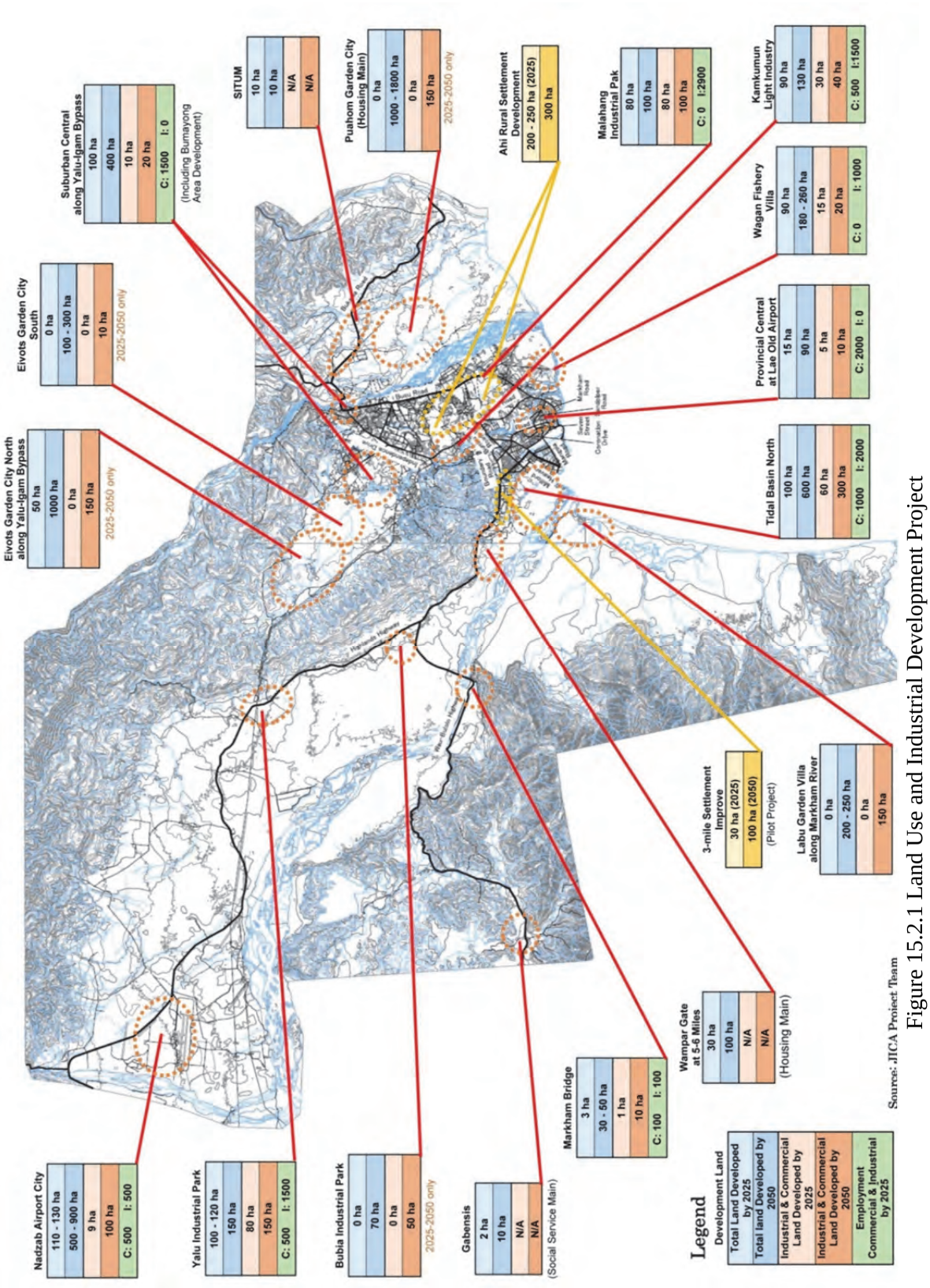
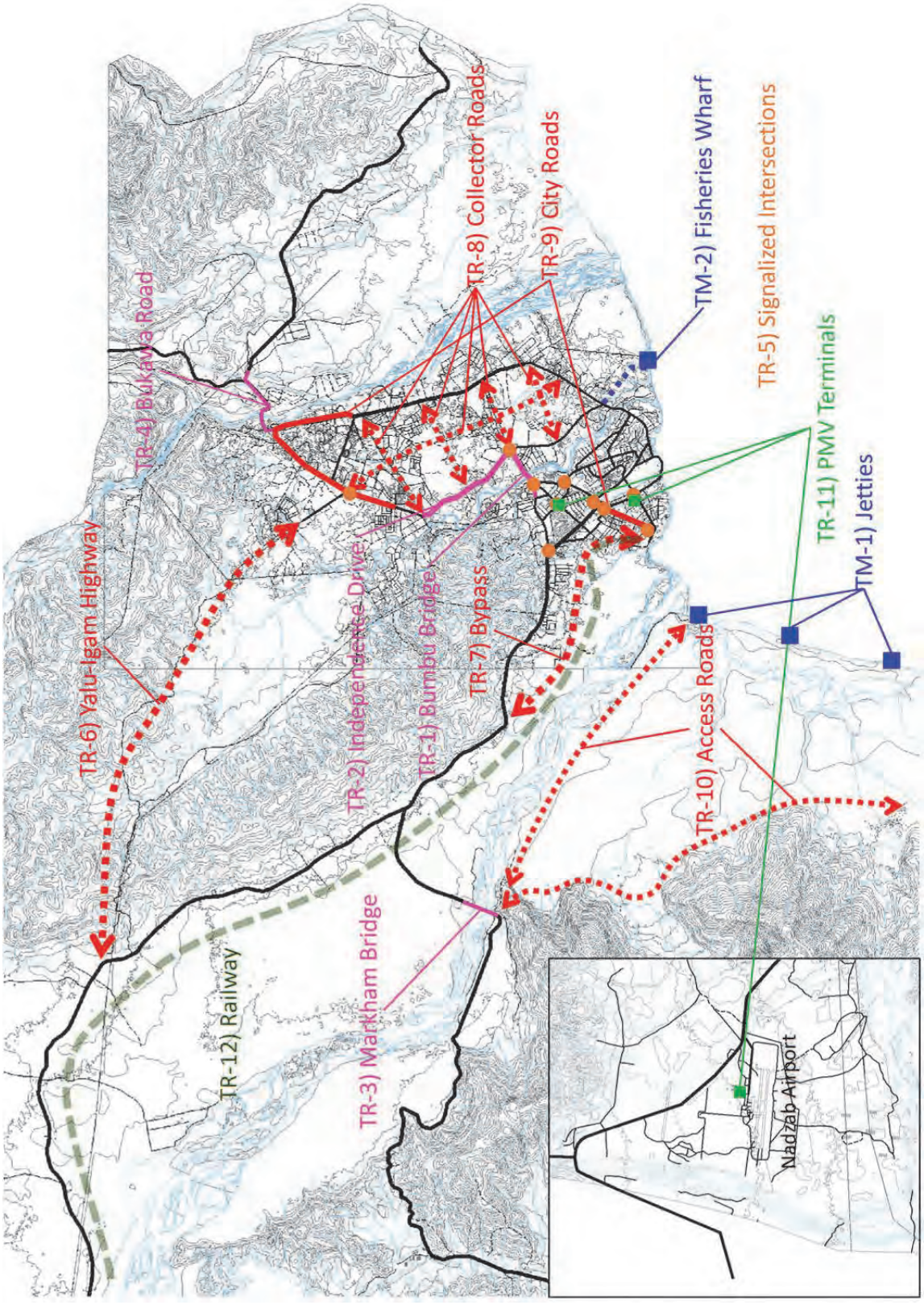


Figure 15.2.1 Land Use and Industrial Development Project



Source: JICA Project Team

Figure 15.2.2 Transport Project

Table 15.2.2 Project Program

(I. Area of study: industrial development)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale Total 2025/2050	Development Scale C&I 2025/2050	Expected Implementation Agency	Schedule (to 2050) 2017 / -2020 / -2025 / -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina) to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
							1 / 3 / 5 / 25																
ID-1	Metal working industry development center	Kamkumun	25.41		30/40	MPA/ICDC	10 / 20 / 10	Must for Employment			2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	7.15	11.91	19.06	6.35	
ID-2	Wood working industry development center	Yalu industrial park	2.62		10/10	MPA/ICDC	5 / 5	Must for Employment			0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.98	1.64	2.62	0.00	
ID-3	Industrial vitalization cluster		5.26		20/20	MPA	20	Must for Industrial System Establishment			1.75	1.75	1.75						5.26	0.00	5.26	0.00	
ID-4	Agro products consolidating depot	Tidal basin	3.94		5/15	MPA	5 / 10	Must for Industrial System Establishment						0.26	0.26	0.26	0.26	0.26	0.00	1.32	1.32	2.62	
ID-5	Food processing industry development center based on setting up of empty-can manufacturing company	Malahang industrial area	3.17		5/5	ICDC	5	Must for Employment			1.06	1.06	1.06						3.17	0.00	3.17	0.00	
Total Cost			40.4						0	0	5.52	5.52	5.52	2.97	2.97	2.97	2.97	2.97	16.56	14.87	31.43	8.97	

(II. Area of study: Land Use)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale Total 2025/2050	Development Scale C&I 2025/2050	Expected Implementation Agency	Schedule (to 2050) 2017 / -2020 / -2025 / -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina) to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
							3 / 5 / 25																
LU-1	Tidal Basin North Development	Lae Port North Zone (composite type)	374.99	100/600		by IPBC (Indep. Pub. Busi. Corp)	70 / 30 / 500	Must for Service Center Development including Market, Vocational, etc.			12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	37.50	62.50	100.00	274.99	
		(Including Javani Industrial Park)	74.99		55/285		35 / 20 / 230	Other industries than I-4			2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	7.50	12.50	20.00	54.99	
			Refer to ID-4		5/15			Refer to ID-4															
			300.00		40/300	PNG Port Corporation	25 / 15 / 260	PNG Port corp.			10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	30.00	50.00	80.00	220.00	
LU-2	Yalu Industrial Park Development	Yalu (composite type)	46.87	80-100/150		Industrial area Planned by MoI (ICDC)	60 / 30 / 60				2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	8.79	14.65	23.44	23.44	
			26.30		50/100		30 / 20 / 50	Promoted by ICDC			1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	4.93	8.22	13.15	13.15	
			Refer to ID-2		10/10			Refer to ID-2											0.00	0.00	0.00		
			12.69		10/20	Growth Center: MPA	5 / 5 / 10				0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	2.38	3.97	6.35	6.35	
			Refer to ID-3		20/20	MPA		Refer to ID-3											0.00	0.00	0.00		
			7.88		10/20		5 / 5 / 10				0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	1.48	2.46	3.94	3.94	
LU-3	Wagan Fishery Park Development (composite type)	Wagan Industrial Zone Development (excluding port construction)	68.40	90/180-260	Including residences	Planned by FA	90 / 170							1.88	1.88	1.88	1.88	1.88	0.00	9.39	9.39	59.01	
			5.25		15/20	Promoted by FA	15 / 5							0.56	0.56	0.56	0.56	0.56	0.00	2.81	2.81	2.44	
			63.15		75/240		75 / 165							1.32	1.32	1.32	1.32	1.32	0.00	6.58	6.58	56.57	
LU-4	Airport City Development	Nearby area of Nadzab Airport (composite type)	221.86	130-150/500-900		to be done by MPA	150 / 750							7.43	7.43	7.43	7.43	7.43	0.00	37.16	37.16	184.70	
			24.64		9/100	Industria area by MPA	9 / 91							0.48	0.48	0.48	0.48	0.48	0.00	2.40	2.40	22.24	
			197.22		141/800		141 / 659							6.95	6.95	6.95	6.95	6.95	0.00	34.76	34.76	162.46	
LU-5	Ahi Rural (KamKanun Area) Settlement Expansion for 30,000	Ahi Rural Kamkanun	166.63	200-250/300		by MPA	50 / 200 / 50				17.36	17.36	17.36	17.36	17.36	17.36	17.36	17.36	52.07	86.79	138.86	27.77	
LU-6	Mahkham Bridge Road Side Service Center Development	Markham Point (composite type)	13.14	3/30-50		Michi-no-Eki by MPA	3 / 47				0.26	0.26	0.26	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.79	12.35	
			2.62		1/10	Commercial	1 / 9				0.09	0.09	0.09						0.26	0.00	0.26	2.36	
			10.52		2/40		2 / 38				0.18	0.18	0.18						0.53	0.00	0.53	9.99	

LU-7	Provincial Center Development at Lae old Airport	Lae Old Airport area (composite type)	23.67	15/90		by MPA/ Private		5	10	75	Development completed: only road construction of 1 km length			0.44	0.44	0.44	0.53	0.53	0.53	0.53	0.53	1.31	2.63	3.94	19.73	
			2.62		5/10	Commercial		5		5				0.44	0.44	0.44						1.31	0.00	1.31	1.31	
			21.05		10/80				10	70							0.53	0.53	0.53	0.53	0.53	0.00	2.63	2.63	18.42	
LU-8	New Urban Area Development at SITUM	Situm area (composite type)	2.62	10/10		Community Service Center by MPA		5	5					0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.98	1.64	2.62	0.00	
LU-9	Labu Tourism Village Development	Labu area (I + II) Especially Labu-I (composite type)	278.44	0/200-300		Tourist Service Center by MPA				300	With Jetti Road: Refer to TR-5											0.00	0.00	0.00	278.44	
			83.32		0/150					150												0.00	0.00	0.00	83.32	
			195.12		0/150					150												0.00	0.00	0.00	195.12	
LU-10	Kamkumun Industrial Area Development (composite type)	Kamkumun area	23.67	90/130		by MPA		20	70	40	Must with Industrial Development			1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	5.92	9.86	15.78	7.89	
			Refer to ID-1		30/40						Refer to ID-1											0.00	0.00	0.00		
			23.67		60/90			10	50	30				1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97	5.92	9.86	15.78	7.89	
LU-11	Gabensis Service Center Development	Gabensis area Community Center (composite type)	2.62	2/10		by MPA		2		8				1.58	1.58	1.58	0.00					4.73	0.00	4.73	-2.11	
LU-12	Suburban Central Development along Yalu-Igam Bypass	Bumayong area Commuity & Commercial Center Improvement (including Bus Terminal)	105.25	100/400		by MPA			100	300							5.26	5.26	5.26	5.26	5.26	0.00	26.31	26.31	78.94	
			5.26		10/20	by MPA			10	10							0.53	0.53	0.53	0.53	0.53	0.00	2.63	2.63	2.63	
			99.99		90/380				90	290							4.74	4.74	4.74	4.74	4.74	0.00	23.68	23.68	76.31	
LU-13	Eivots Garden Center North Development along Yalu-Igam Bypass	This project is planned in vast land along Yalu-Igam Bypass.	263.15	50/1000		by MPA			50	950							2.63	2.63	2.63	2.63	2.63	0.00	13.16	13.16	249.99	
			39.47		0/150	by MPA			0	150												0.00	0.00	0.00	39.47	
			223.68		50/850				50	800							2.63	2.63	2.63	2.63	2.63	0.00	13.16	13.16	210.52	
LU-14	Eivots G.C. South Development	This project is planned in vast land along Yalu-Igam Bypass.	78.94	0/100-300		by MPA			0	300												0.00	0.00	0.00	78.94	
			2.63		0/10				0	10												0.00	0.00	0.00	2.63	
			76.31		0/290				0	290												0.00	0.00	0.00	76.31	
LU-15	3-mile Settlement Improvement	Neighboring area of Lae City (Development by community) Pilot Project	26.31	30/100		Initial Fund by MPA, Dev. Action by Community			30	70	Must as Polit Project, but area size is not specific						1.58	1.58	1.58	1.58	1.58	0.00	7.89	7.89	18.42	
LU-16	Malahang Industrial Park	Western area of Busu Road	24.99	80/100		by MPA		50	30	20	To be developed by the industries that intend to invest			2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	7.40	12.33	19.73	5.26	
			24.99		75/95	by MPA		45	30	20				2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	7.40	12.33	19.73	5.26	
			0.00		5/5	by ICDC					Refer to I.-5											0.00	0.00	0.00	0.00	
LU-17	Puahom Garden City Development	Area along Busu Road	473.69	0/1000-1800		by MPA				1800												0.00	0.00	0.00	473.69	
			39.47		0/150	by MPA				150												0.00	0.00	0.00	39.47	
			434.22		0/1650					1650												0.00	0.00	0.00	434.22	
LU-18	Bubia Industrial Park Development	Bubia	18.41	0/70		by MPA				70												0.00	0.00	0.00	18.41	
			13.15		0/50	by MPA				50												0.00	0.00	0.00	13.15	
			5.26		0/20					20												0.00	0.00	0.00	5.26	
LU-19	Wampar Gate Development	Housing	55.54	30/100		by MPA			30	70							3.33	3.33	3.33	3.33	3.33	0.00	16.66	16.66	38.88	
LU-20	Abongtu Garden Villa	Area along Busu Road	36.17	44/44		by private company						18.09	18.09									36.17	0.00	36.17	0.00	
Total Cost			2,269.19									18.09	18.09	39.83	39.83	39.83	60.19	60.19	60.19	60.19	60.19	155.66	300.97	456.63	1,848.73	

(III. Area of study: Transport)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale	Expected Implementation Agency	Schedule (to 2050) 2017 -2020 -2025 -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina) to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
TR-1	Widening of North Bumbu Bridge and related roads	North Bumbu Bridge and its approaching roads	18.4	Construction of 2-lane bridge, L=50m Reconstruction of 2-lane bridge, L=50m Widening of Bumbu Road into	by LULLG with MPA/DoW							6.13	6.13	6.13				6.13	12.27	18.40	0.00	
TR-2	Widening of Independence Drive	Independence Drive	10.2	Widening into 4-lane, L=3.1km	by LULLG with MPA/DoW										5.10	5.10		0.00	10.20	10.20	0.00	
TR-3	Widening of Markham Bridge	Markham Bridge	40.8	1-lane new bridge L=560m	by DoW										13.60	13.60	13.60	0.00	40.80	40.80	0.00	
TR-4	Widening of Bukawa Road	Bukawa Road	14.2	Widening into 2-lene, L=2.1km Reconstruction of two bridges with 2-lane, L=60m & 30m	by DoW										7.10	7.10		0.00	14.20	14.20	0.00	
TR-5	Signalization of intersections in Lae City	Lae City	22.2	Signalization of 10 existing intersections	by LULLG with MPA/DoW							7.40	7.40	7.40				7.40	14.80	22.20	0.00	
TR-6	Construction of Yalu-Igam Highway	Area between Yalu and Igam	21.6	2-Lane Paved L=14km	by District Office with MPA/DoW								7.20	7.20	7.20			0.00	21.60	21.60	0.00	
TR-7	Construction of Bypass Highway behind Lae Tidal Basin	Area behind Lae Tidal Basin	11.1	2-Lane Paved L=7.2km	by LULLG with MPA/DoW						5.55	5.55						11.10	0.00	11.10	0.00	
TR-8	Construction of Collector Roads between Independence Drive and Busu Road	Ahi Rural Kamkumun area	26.8	5 new roads with 2-lane, L=17.4km	by District Office with MPA/DoW										8.93	8.93	8.93	0.00	26.80	26.80	0.00	
TR-9	Rehabilitation of Lae City Roads	Lae City	12.4	Two roads with 2-lane, L=8.1km	DOW					12.40								12.40	0.00	12.40	0.00	
TR-10	Rehabilitation of two access roads to Labu areas	Labu area	19.5	Two gravel roads with 1-lane, L=30km	by MPA								19.50					0.00	19.50	19.50	0.00	
TR-11	Construction of PMV Terminals	Main Market area, Eriku area and Nadzab Airport City	16.7	3 terminals with concrete pavement (A=0.6ha for each)	by LULLG						16.65							16.65	0.00	16.65	0.00	
TR-12	Feasibility Study for Railway between Highlands Region and Lae	Between Highlands Region and Lae	5.0		DOT											2.50	2.50	0.00	5.00	5.00	0.00	
TR-13	Technical Assistance for PMV Management		7.0		MPA					2.33	2.33	2.33						7.00	0.00	7.00	0.00	
TR-14	Technical Assistance for Road Maintenance		7.0		LULLG								2.33	2.33	2.33			0.00	7.00	7.00	0.00	
TM-1	Construction of Jetties for Labu	Labu area	1.0	3 jetties	District Office						1.00							1.00	0.00	1.00	0.00	
TM-2	Development of Fisheries Wharf in Wagang	Wagang village	663.6	Construction of fisheries wharf Construction of access road	by National Fishery Authority (Phase 1)						94.80	94.80	94.80	94.80	94.80	94.80	94.80	189.60	474.00	663.60	0.00	
Total Cost			897.5					0.00	0.00	14.73	120.33	116.22	137.37	117.87	139.07	132.03	119.83	245.15	568.70	813.85	0.00	
Total Cost excluding Fishery Wharf			233.9					0.00	0.00	14.73	25.53	21.42	42.57	23.07	44.27	37.23	25.03					

(IV. Area of study: Countermeasures for Flood Control)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale	Expected Implementation Agency	Schedule (to 2050) 2017 -2020 -2025 -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina) to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
FC-1	River Improvement in the lower reaches of the Markham River	The lower reachs of Markham River	215.58	50-year return period	Department of Works, PNG													0.00	0.00	0.00	215.58	
FC-2	Ground Raising	The right bank site of the Markham Bridge in the Markham River	5.57	50-year return period	Department of Works, Morobe		The project cost shall be integrated in LU-6.						2.79	2.79				0.00	5.57	5.57	0.00	
FC-3	River Improvement of the Erap River	The Erap River	191.25	50-year return period	Department of Works, PNG										7.08	7.08	7.08	0.00	21.25	21.25	170.00	
FC-4	River Improvement of the lower reaches of the Bumbu River	The lower reaches of the Bumbu River	68.49	50-year return period	Department of Works, PNG								2.74	2.74	2.74	2.74	2.74	0.00	13.70	13.70	54.79	
FC-5	River Improvement of the upper reaches of the Bumbu River	The lower reaches of the Bumbu River	72.18	50-year return period	Department of Works, PNG													0.00	0.00	0.00	72.18	
FC-6	River Improvement of the lower reaches of the Busu River	The lower reaches of the Busu River	1,720.22	50-year return period	Department of Works, PNG													0.00	0.00	0.00	1720.22	
Total Cost			2,273.29					0.00	0.00	0.00	0.00	0.00	2.74	2.74	9.82	9.82	9.82	0.00	40.52	40.52	2,232.77	

(V. Area of study: Water Supply)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale	Expected Implementation Agency	Schedule (to 2050) 2017 -2020 -2025 -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina) to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
WS-1	Water Supply Development in Lae	Lae urban and Ahi Rural between Markham River and Busu River	461.23					16.30	16.30	18.31	18.31	18.31	21.71	21.71	21.71	21.71	21.71	87.54	108.53	196.07	265.16	
WS-1-1	Rehabilitation and Function Enhancement	Existing Water Supply Area and others	287.48	Water source Submersible pump	Water PNG			16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.30	81.52	81.52	163.03	124.45	
WS-1-2	Tidal Basin North	Lae Port North Zone (composite type)	22.15	Pipeline	Water PNG					0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	1.38	2.31	3.69	18.46	
WS-1-3	Wagan Fishery Villa	Wagan Industrial Zone Development (excluding port construction)	6.64	Pipeline	Water PNG								0.52	0.52	0.52	0.52	0.52	0.00	2.58	2.58	4.06	
WS-1-4	Ahi Central	Ahi Rural Kamkanun	10.33	Pipeline	Water PNG					0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	1.11	1.84	2.95	7.38	
WS-1-5	Provincial Central at Lae Old Airport	Lae Old Airport area (composite type)	3.32	Pipeline	Water PNG					0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.21	0.34	0.55	2.77	
WS-1-6	Kamkumun Light Industry	Kamkumun area	4.80	Pipeline	Water PNG					0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.83	1.39	2.22	2.58	
WS-1-7	Buimo Garden Villa	Buimo area	1.11	Pipeline	Water PNG					0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.69	1.11	0.00	
WS-1-8	Igam Garden Villa	North of Bumayong area	3.69	Pipeline	Water PNG					0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.42	0.69	1.11	2.58	
WS-1-9	Abong Garden Villa	Bumayong area	1.48	Pipeline	Water PNG					0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.56	0.93	1.48	0.00	
WS-1-10	Suburban Central along Yalu-Igam Bypass	Bumayong area Community & Commercial Center Improvement (including Bus Terminal)	14.76	Booster Pump Station Booster Pump Pipeline	Water PNG								0.52	0.52	0.52	0.52	0.52	0.00	2.58	2.58	12.18	
WS-1-11	Eivots Garden City North along Yalu-Igam Bypass		68.55	Pipeline	Water PNG								1.70	1.70	1.70	1.70	1.70	0.00	8.49	8.49	60.06	
WS-1-12	Eivots Garden City South		25.84	Pipeline	Water PNG													0.00	0.00	0.00	25.84	
WS-1-13	3-mile Settlement Improve	Neighboring area of Lae City (Development by community) Pilot Project	3.69	Pipeline	Water PNG								0.22	0.22	0.22	0.22	0.22	0.00	1.11	1.11	2.58	
WS-1-14	Malahang Industrial Expansion	Malahang area	3.69	Pipeline	Water PNG					0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	1.11	1.84	2.95	0.74	
WS-1-15	Wampar Gate at 5-6 miles	West of Lae city	3.70	Pipeline	Water PNG								0.44	0.44	0.44	0.44	0.44	0.00	2.22	2.22	1.48	
WS-2	SITUM	Situm area (composite type)	1.56	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG					0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.51	0.84	1.35	0.21	
WS-3	Puahom Garden City		84.10	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG													0.00	0.00	0.00	84.10	
WS-4	Bubia Industrial Park		7.55	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG													0.00	0.00	0.00	7.55	
WS-5	Yalu Industrial Park	Yalu (composite type)	19.68	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG					1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	4.51	7.52	12.03	7.65	

WS-6	Nadzab Airport City	Nearby area of Nadzab Airport (composite type)	93.76	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG												2.85	2.85	2.85	2.85	2.85	0.00	14.27	14.27	79.49	
WS-7	Markham Bridge	Markham Point (composite type)	6.86	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG										1.16	1.16	1.16						3.47	0.00	3.47	3.39	
WS-8	Gabensis	Gabensis area Community Center (composite type)	3.71	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG										0.92	0.92	0.92						2.75	0.00	2.75	0.96	
WS-9	Labu Garden Villa along Markham River	Labu area (I + II) Especially Labu-I (composite type)	35.20	Water source Submersible pump Purification plant Reservoir tank Pipeline	Water PNG																		0.00	0.00	0.00	35.20	
Total Cost			713.65												16.30	16.30	22.06	22.06	22.06	26.23	26.23	26.23	26.23	26.23	98.78	131.17	229.94	483.71	

(VI. Area of study: Sewerage)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale	Expected Implementation Agency	Schedule (to 2050)				Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina)				
						2017	-2020	-2025	-2050												to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
SW-1	Sewerage Development in Lae Phase-1	Lae urban and Ahi Rural between Markham River and Busu River, Southern area than Taraka	364.473								0.00	58.63	58.63	58.63	58.63	61.17	61.17	2.54	2.54	2.54	234.51	129.96	364.47	0.00	
SW-1-1	Rehabilitation and Function Enhancement	Existing Sewer Area	218.40	Rehabilitation of sewer network (2,452ha) Pump station to STP	Water PNG							36.40	36.40	36.40	36.40	36.40	36.40				145.60	72.80	218.40	0.00	
SW-1-2	Lae Sewage Treatment Plant (STP) PH-1	Tidal Basin North	133.37	41,000m^3/day	Water PNG							22.23	22.23	22.23	22.23	22.23	22.23				88.91	44.46	133.37	0.00	
SW-1-3	Provincial Center Development at Lae old Airport PH-1	Lae Old Airport area	5.62	Sewer network (80ha)	Water PNG											1.12	1.12	1.12	1.12	1.12	0.00	5.62	5.62	0.00	
SW-1-4	3-mile Settlement Improve	3-mile Settlement	2.88	Sewer network (41ha)	Water PNG											0.58	0.58	0.58	0.58	0.58	0.00	2.88	2.88	0.00	
SW-1-5	Wampar Gate Development PH-1	Housing area	4.21	Sewer network (60ha)	Water PNG											0.84	0.84	0.84	0.84	0.84	0.00	4.21	4.21	0.00	
SW-2	Sewerage Development in Lae Phase-2	Lae urban and Ahi Rural between Markham River and Busu River, Taraka & Northern area than Taraka	351.41																70.32	70.32	0.00	140.63	140.63	210.78	
SE-2-1	Rehabilitation and Extension	Existing Sewer Area in Taraka / UNITEC and Surroundings	53.23	Rehabilitation / Extenssion of Sewer network (758ha)	Water PNG														7.60	7.60	0.00	15.21	15.21	38.02	
SW-2-2	Lae Sewage Treatment Plant (STP) PH-2	Tidal Basin North	179.59	41,000m^3/day extenssion Extension of Pump station to STP	Water PNG														59.86	59.86	0.00	119.73	119.73	59.86	
SW-2-3	Sewer Extension along Independence Road	Along Independence Road between Buimo and Omili	19.94	Sewer network (284ha)	Water PNG														2.85	2.85	0.00	5.70	5.70	14.24	
SW-2-4	Provincial Center Development at Lae old Airport PH-2	Lae Old Airport area	5.27	Sewer network (75ha)	Water PNG																0.00	0.00	0.00	5.27	
SW-2-5	Tidal Basin North Development	Lae Port North Zone	42.13	Sewer network (600ha)	Water PNG																0.00	0.00	0.00	42.13	

SW-2-6	Wagan Fishery Park Development	Wagan Industrial Zone Development (excluding port construction)	12.64	Sewer network (180ha)	Water PNG																	0.00	0.00	0.00	12.64	
SW-2-7	Ahi Rural (KamKanun Area) Settlement Expansion for 30,000	Ahi Rural Kamkanun	9.83	Sewer network (140ha)	Water PNG																	0.00	0.00	0.00	9.83	
SW-2-8	Kamkumun Industrial Area Development (composite type)	Kamkumun area	9.13	Sewer network (130ha)	Water PNG																	0.00	0.00	0.00	9.13	
SW-2-9	Wampar Gate Development PH-2	Housing area	2.81	Sewer network (40ha)	Water PNG																	0.00	0.00	0.00	2.81	
SW-2-10	Malahang Industrial Park	Malahang	16.85	Sewer network (240ha)	Water PNG																	0.00	0.00	0.00	16.85	
SW-3	Suburban Central Development along Yalu-Igam Bypass	Bumayong area Community & Commercial Center Improvement (including Bus Terminal)	67.27	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													3.68	3.68	3.68	3.68	0.00	14.71	14.71	52.56	
SW-4	Eivots Garden Center North Development along Yalu-Igam Bypass	Along Yalu-Igam Bypass	158.19	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													6.48	6.48	6.48	6.48	0.00	25.91	25.91	132.28	
SW-5	Eivots G.C. South Development	Along Yalu-Igam Bypass	71.92	Sewage Treatment Plant ($7,000m^3/d$) Sewer network (700ha)	Water PNG																	0.00	0.00	0.00	71.92	
SW-6	Puahom Garden City Development	Puahom	78.94	Sewage Treatment Plant ($7,000m^3/d$) Sewer network (800ha)	Water PNG																	0.00	0.00	0.00	78.94	
SW-7	Yalu Industrial Park Development	Yalu	35.39	PH-1: Sewage Treatment Plant ($1,900m^3/d$) Sewer network (90ha) PH-2: Sewage Treatment Plant ($1,900m^3/d$ extension) Sewer network (60ha)	Water PNG													3.13	3.13	3.13	3.13	0.00	12.50	12.50	22.89	
SW-8	Airport City Development	Nearby area of Nadzab Airport	108.71	PH-1: Sewage Treatment Plant ($1,900m^3/d$) Sewer network (120ha) PH-2: Sewage Treatment Plant ($7,600m^3/d$ extension) Sewer network (780ha)	Water PNG													3.65	3.65	3.65	3.65	0.00	14.61	14.61	94.10	
SW-9	Labu Tourism Village Development	Labu area (I + II) Especially Labu-I	37.07	Sewage Treatment Plant ($6,000m^3/d$) Sewer network (250ha)	Water PNG																	0.00	0.00	0.00	37.07	
Total Cost			1,273.38									0.00	58.63	58.63	58.63	58.63	61.17	78.10	19.47	89.79	89.79	234.51	338.32	572.83	700.55	

(VII. Area of study: Waste Management)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale	Expected Implementation Agency	Schedule (to 2050) 2017 -2020 -2025 -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Milion Kina) to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
WM-1	Rehabilitation of the Existing Dumpsite	Construction of sanitary landfill	8.50	3.5 ha	Lae District		3 million/ha			4.25	4.25							8.50	0.00	8.50	0.00	
		Closure of existing dumping site	0.00	7.5 ha														0.00	0.00	0.00	0.00	
WM-2	Construction of new sanitary landfill	Behind Tidal Basin North zone	46.00	16 ha	Lae District		3 million/ha											0.00	0.00	0.00	46.00	
WM-3	Expansion of solid waste collection system	Lae District and the other districts	4.98	Coverage population forcast: in 2015: 84,000 in 2025: 99,000	Lae District: Outsourcing								1.00	1.00	1.00	1.00	1.00	0.00	4.98	4.98	0.00	
WM-4	Construction of new sanitary landfill	Nazab Airport City	5.00	1.0 ha/1.5 ha	Wampar District		3 million/ha + adm. Build.										3.33	0.00	3.33	3.33	1.67	
Total Cost			64.48					0.00	0.00	4.25	4.25	0.00	1.00	1.00	1.00	1.00	4.33	8.50	8.31	16.81	47.67	

(VIII. Area of study: Social Service)

	project title	proposed location	Development Cost (Mil. Kina)	Development Scale	Expected Implementation Agency	Schedule (to 2050) 2017 -2020 -2025 -2050	Remark	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cost of Project (Million Kina) 2018 to 2020	2021 to 2025	M/P Total	2026 to 2050	Remark
SS-1	Facility Capacity and Accessibility improvement for the Primary Schools in the Study area	All Study Area	801.00	Approximately 800 classrooms and 850 teachers quarters to be constructed with necessary fasilities, such as tilets, teachers room, etc. in the whole target area.	MPA / Division of Education					25.03	25.03	25.03	25.03	25.03	25.03	25.03	25.03	75.09	125.16	200.25	600.75	
SS-2	Capacity and Service Quality improvement for the Healthcare Facilities in the Project area	All Study Area	84.00	Minimum 14 CHP to be constructed, 11 Aidpost to be constructed, and 13 service improvement on existing facilities to be made in the whole target area.	MPA / Division of Health					2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	7.88	13.13	21.00	63.00	
SS-3	Public Park and Amenity Facility development in the Project area	All Study Area	23.00	Approximately 85 police stations to be constructed in the whole target area.	MPA / Division of Community Services							0.77	0.77	0.77	0.77	0.77	0.77	0.77	3.83	4.60	18.40	
SS-4	Ward Level Community Center development in the Project area	All Wards in Study Area	48.00	Minimum 60 Community Centers to be constructed in the whole target areas considering each Ward.	MPA / Division of Community Services					1.50	1.50							3.00	0.00	3.00	45.00	
SS-5	Police Station development in the Projecrt area	All Study Area	53.00	Approximately 85 police stations to be constructed in the whole target area.	Police Authority, MPA					1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	4.97	8.28	13.25	39.75	
SS-6	Sports Facility development in Lae	At existing Lae Football Association Ground in Eriku, Lae	40.00	Approximately 110 local parks to be constructed in the whole target area.	MPA/ Division of Community Services /LULLG										1.43	1.43	1.43	0.00	4.29	4.29	35.71	
Total Cost			1009.00					0.00	0.00	30.81	30.81	30.08	30.08	30.08	31.51	31.51	31.51	91.70	154.68	246.39	802.61	
Ovrall Total Cost									93.02	193.91	281.43	264.93	314.35	311.78	290.27	353.55	344.68	849.59	1,620.20	2,469.79	6,125.02	
Overall Total Cost excluding Port									0.00	45.55	56.35	44.10	67.99	48.49	85.60	78.56	66.36	91.70	195.20	286.90	3,035.39	
																	492.98371					
Balance																	54.78					

Source: JICA Project Team

15.3 Project Profile

The Project profile of each sub-project is described in the Project Profile sheet in the Appendix 9 of the Report.

15.4 Selection of Priority Projects

(1) Selection criteria

Priority projects are selected to be implemented in near future. The projects proposed in the urgent term are again evaluated in terms of eligibility.

The criteria for choosing priority projects are following.

- To guide proposed urban structure
- To meet the urgent needs of residents
- To meet the urgent needs for industrial development
- To transfer knowledge and techniques for the implementation to counterpart
- To meet the JICA Project scheme (Project scale, applicability of Japanese advanced technology)

(2) Opinions from residents and governmental agencies

The household interview survey results conducted in this Project revealed the following residents' difficulty and highest needs in living in Lae-Nadzab area.

In rural areas people are having difficulties with lack of electricity, water supply and drainage and sewer system, while people in Lae City concern crimes and violence or ethnic clashes in the area. Healthcare and educational facilities are common concern following the basic infrastructure and reduction of crimes. Since residents felt lack of water, electricity, roads in residents' everyday life, residents didn't put high priority on the economic development.

Table 15.4.1 Opinion on the Priority Projects

No.	Organization	Comments
1	Morobe Provincial Administration	The Governor and Administrator indicate that two industrial development/land use projects shall be prioritized. One is Yalu Industrial Park and the other is Provincial Centre Development at Lae Old Airport. Since the Old Airport area development was proposed long time ago, the actual land use hasn't happened as yet. The location has high potential for the formation of Provincial Centre in line with the Morobe Provincial Integrated Development Plan. They added Yalu Igam Highway construction.
2	LULLG	Three projects are proposed from LULLG. Those are a) Rehabilitation of Second Seven Dumpsite Landfill, b) Sports Facility Development, c) Provincial Centre Development at Lae Old Airport. As for the Sports Facility Development, the candidate site is present Lae Football Association ground in Eriku. LULLG has estimated the Project cost 40 mil. Kyat.
3	Other LLG	Opinions are shown at WG.
4	DLPP	DLPP's view on priority projects are for Yalu Industrial Park Development and Yalu Igam highway Construction projects. Yalu Industrial Park should be prioritized. Because there are large number of small-scale individual farmers within Lae-Nadzab area, they can use the road aa a starting ground. Regarding Yalu Igam highway, it seems quite costly but is very important as it will open up development to other places on the far end of the road. The highway will reduce transport cost for goods/services to reach people, business houses, etc.
5	Department of National Planning & Monitoring	Not obtained
6	Department of Works	From the viewpoint of transport improvement, Yalu Igam highway is recommended. The road will give direction for the urbanization.

No.	Organization	Comments
7	Department of Trade Commerce and Industry	Yalu Industrial Park Project is recommended. They are ready to consult with DLPP.
8	PNG Ports Corporation	PNG Ports Corporation is interested in two projects, one is Tidal Basin North Development and other is Construction of Bypass Highway behind Lae Tidal Basin. Out of these projects PNG Ports Corporation recommend the latter project. The Tidal Basin North Development will follow the Bypass Highway. The PNG Port Corporation can say only possible for the sewerage treatment facility in the Tidal Basin North Development Project Area. The funding source for industrial development in Portion 508 is not yet secured. There is a possibility to ask Japanese ODA loan Project. It is recommended to consult Project Specialist (Robert Hancock, POM) on that matter.

Source: JICA Project Team

(3) Candidate prioritized projects

Different from urgently needed projects to solve the facing problems, priority projects are desirable to guide fundamental direction of urban development. In line with the investment principle importance should be placed on the economic development.

Also the priority project should be subject to the JICA Project principles, namely self-help effort project and infrastructure project because of the scope of work of this Project. In consideration of above, following projects are proposed as a candidate of priority project.

- Yalu Industrial Park Development
- Tidal Basin North Development
- Provincial Centre Development at Lae old Airport
- Construction of Bypass Highway behind Lae Tidal Basin
- Construction of Yalu-Igam Highway

Table 15.4.2 Proposed Prioritized projects

No	Sector	Project Title	Scale	Cost Scale	Rationale	Needs/Urgency	Urban Structure	Industrial Development	Eligibility for Japanese Grant Aid Scheme	Practicability	Rating
1	Industrial Development	Yalu Industrial Park Development	150ha(2050) 100~120ha (2025)	Medium	It is proposed to foster woodworking companies capable of making furniture and woodwork products that meet the actual needs in PNG. This program aims at improving employment, business start-up, market access, and support for small and middle sized enterprises by technical training testing/inspection, and business promotion, which lead to creation of industrial cluster. ICDC has changed the target for Yalu Industrial Park from agricultural processing industry to Export Processing Zone (EPZ).	Yalu Industrial Park is effectively located at the middle point between Lae and Nadzab to formulate future urban structure. In this regard, it should be developed at early stage. Fostering SMEs together with human resource development is essential to improve the current economic situation; therefore Yalu Industrial Park is expected to have such functions. (◎)	It is located major service center in Lae-Nadzab area. It will helpful to develop future urban structure or functional allocation. (◎) 	It is effective for SME industrial development. (◎)	The developed land is sold or leased. Since it is considered a profitable project, it doesn't so much fit Japanese Grant scheme.(○)	The area is basically state land. However, former customary land owners are insisting to return back the land respecting the promise between them and Morobe Provincial Administration in the past . The cause of suspension of project implementation is that MoA between ICDC and former customary land owners is not signed yet. The estimated cost for feasibility study is 5mil.Kyat. (◎)	Rating: 9 ICDC is planning Yalu Industrial Park Development, however, the implementation process is reportedly behind the schedule.
2	Industrial Development	Tidal Basin North Development	600ha(2050) 300ha(2025)	High	It is proposed to develop industrial area at Port North Zone utilizing the transport facility of Lae port and Highlands Highway. Javani Industrial Park is included. The project include levee cum flood protection, access road, water supply, sewerage and storm water drainage system. Land reclamation would be necessary.	The development of Tidal Basin North will be a base for Lae-Nadzab area to become center of industry and logistics in PNG. Currently PNG Port Corporation has right to develop the land offering that to private sector. However, development scale is rather small and sewerage treatment facility and dumping site is proposed by the JICA Project Team. The development plan should be immediately made from overall viewpoint of Lae-Nadzab area. (◎)	It is a major land use to promote industrial/logistic center for Lae Nadzab area in line with the National development policy. It will helpful to develop future urban structure or functional allocation. (◎) 	It is vital for the Lae Nadzab area industrialization together with Tidal Basin Development and Highlands Highway. (◎)	The total project cost is rather beyond the grant aid project. The developed land is sold or leased. Since it is considered a profitable project, it doesn't so much fit Japanese Grant scheme.(○)	The area is located on state land and surveyed customary land. Currently PNG Ports Corporation (SOE) has a right to develop the state land area next to the port (Portion 508) given by the National Government. However the remaining area for industrial development comes still under the surveyed customary land. Some land acquisition procedure for the use of customary land would be necessary. As for the landfill site and wastewater treatment within the industrial area under the PNG Ports Corporation, Morobe Provincial Government shall consult Project Management Unit. (▲)	Rating: 6 Total project cost is rather beyond those of grant aid project, but loan project.
3	Land Use	Provincial Center Development at Lae old Airport	90ha(2050) 15ha(2025)	Low	It is proposed to develop new urban core at old Lae Airport site. The project will include design of the urban complex at old Lae Airport, and construction of road network, water supply, sewerage, and storm water drainage system.	It is urgent and essential needs for the imminent business/commercial development for Lae Nadzab area. Currently sites for court, police, and hospital are	The project will intensify the CBD function of Lae-Nadzab area. It will helpful to develop future urban structure or functional allocation. (◎)	It is helpful to give location area for new urban functions. (○)	The developed land is sold or leased. Since it is considered a profitable project, it doesn't so much fit Japanese Grant scheme.(○)	The area is located on state land and leased land to the private sector. There is a UDL between Morobe Provincial Government and private sector. However in the UDL contract the former customary land owners. However, it is stipulated that	Rating 8 There is still dispute over the land ownership. Though LLG think the land right are already settled. The delay of

					Currently the 24 allotments are allocated to LULLG. The area is designated as redevelopment zone in 1996, and from then on the allotments are changed several times by the chief physical planner in consultation with Department of Lands, Morobe Provincial Government. However no clear future development image of the area is prepared as yet.	designated. Waste water treatment system is also proposed in the area by PNG water. The development plan should be immediately reconsidered from overall viewpoint of Lae-Nadzab area. (◎)				former customary land owners are allowed to have a privilege right to use the land in the UDL contract, and land owners are protesting the land rights. The obstacle for the project implementation is the lack of fund for development (◎)	the implementation is basically attributable to the lack of funding resource.
4	Transport	Construction of Bypass Highway behind Lae Tidal Basin	7.2km	Low	This is the project for constructing new bypass highway connecting Lae Port to the Highlands Highway at 6 Mile. This new highway will function as alternative road of the Highlands Highway to exclude through traffic between Lae Port and Nadzab or Highland area from Lae City.	The road is expected to bear cargo traffic related to Lae Port. Heavy trucks shall use this road. The road construction will be the precondition for Tidal Basin North Development (◎)	It is helpful to separate port related cargo traffic from general traffic in the Lae City. It will helpful to develop future urban structure.. (◎)	It is helpful to develop future industrial development.. (◎)	It is suitable for Japanese grant aid project because no revenue is expected. (◎)	New road construction. The road passes through state land and surveyed customary land. The road delineation can be drawn within the state lands. (◎)	Rating: 10 In case the road only passes the state lands the implementation is easy.
5	Transport	Construction of Yalu-Igam Highway	17.3km	Medium	This is the project for constructing new highway connecting Igam road to the Highlands Highway at Yalu area. The new highway is expected to function as alternative road of the Highlands Highway to exclude through traffic between the east and the west from Lae City center. Moreover, the development of new Garden City is proposed along this highway.	It is urgent and essential to guide future urbanization, otherwise arbitrary development may proceed along Highlands Highway. Cargo traffic between Marahang Industry area and Highlands have to pass the current Lae City and make a long way detour. Improvement and development of the road is urgently necessary. (○)	It is greatly helpful to guide urbanization. It will helpful to develop future urban structure or functional allocation.. (◎)	It gives the road network for newly proposed industrial development along this road. . (○)	It is suitable for Japanese grant aid project because no revenue is expected. (◎)	Present road widening and improvement. However, considerable portion is entirely new construction. Although the land owners are only five persons in the Yalu area, however, the portion of new construction in Igam area passes through customary land (▲)	Rating: 5 Land acquisition is deemed to take time.

Note: Other than above LULLG proposed a) Rehabilitation of Second Seven Dumpsite Landfill, b) Sports Facility Development, c) Old Airport
Source: JICA Project Team

Application of Japanese Technology

1) Water Supply

The proposed project of water supply is not independent but is related to the proposed prioritized projects mentioned above. In this case, prioritized projects for water supply are;

a) Water supply facilities in Yalu area

Development of water source, Chlorine sterilization station, Reservoir tank, Pipeline

b) Expansion and rehabilitation of water supply facilities in Lae City (Tidal Basin North Development, Provincial Centre Development at Lae Old Airport)

Development of water source, Pump station with chlorine sterilization, Reservoir tank, Rehabilitation of existing pipeline, Expansion of pipeline

Superiority of Japanese technology regarding the water supply sector is not expected. Current water supply system is very simple (water quality is no problem, just chlorine sterilization is necessary), if new Project for water supply is established, it is not necessary to consider the complex equipment for the facilities. Currently, the material and equipment of water supply facilities in Lae are made in Australia and Europe, and there are no problems to select those products.

2) Solid Waste Management

Semi-aerobic landfill structure (Fukuoka Method) was developed by Emeritus Professor Hanashima of Fukuoka University in association with Fukuoka City in 1970s. Thus superiority of Japanese technology of this system is expected. The noticeable characteristics are as follows;

- Leachate is immediately removed;
- Generation of methane (CH4) is mitigated by aerobic conditions inside of waste;
- Wastes are stabilized earlier and maintenance is easier than the other types; and
- Initial cost is lower than the other types

This system is proposed for the rehabilitation of Second Seven Dumpsite, new landfill sites located in Tidal Basin North (tentative) and Nadzab area.

(4) Selection of Prioritized projects

Two Working Group meeting were held focusing on the selection of prioritized projects.

At the Working Group meetings governmental officials presented their opinions on the urgent needs of not only residents but also urgent needs to develop industry.

At the 13th Working Group Meeting on 14th March, the JICA Study Team explained hearing results from relevant organizations including Morobe Provincial Administration, LULLG, DLPP, DoW and PNG Ports on their opinion about prioritized project, and importance of the land use (acquisition) issues and applicability of Japanese technology. Then selection of the prioritized project was conducted.

The Tidal Basin North Development was considered to be a major Project for Lae-Nadzab area to be an industrial base for whole PNG. And it should be planned not only the lands under the PNG ports corporation but whole area (300ha) of the Tidal Basin North. The area is also the site for wastewater treatment facilities and dumping site of solid wastes. Thus integrated planning should be made and the total Project costs would be large. Therefore, the Working Group meeting concluded that loan scheme is suitable for the Project.

The Provincial Centre Development at Lae Old Airport was at first recommended by Morobe Provincial Administration and LULLG. However at the Working Group meeting, city planner raised his opinion that prioritized projects shall be the project that guide the future urban structure, and the plan for Provincial Centre Development at Lae old Airport Project should be entrusted to the private sector consultant.

After all, projects of Yalu Industrial Park Development, Yalu - Igam Highway construction, and Bypass Highway behind Lae Tidal Basin were selected. The Working Group could not narrow down the priority projects any further.

At the Working Group meeting, members requested JICA Study Team to conduct pre-feasibility study for not only one prioritized Project. The JICA Study Team answered that it should be a matter of JICA, however they relay your request to JICA PNG office and JICA HQ.