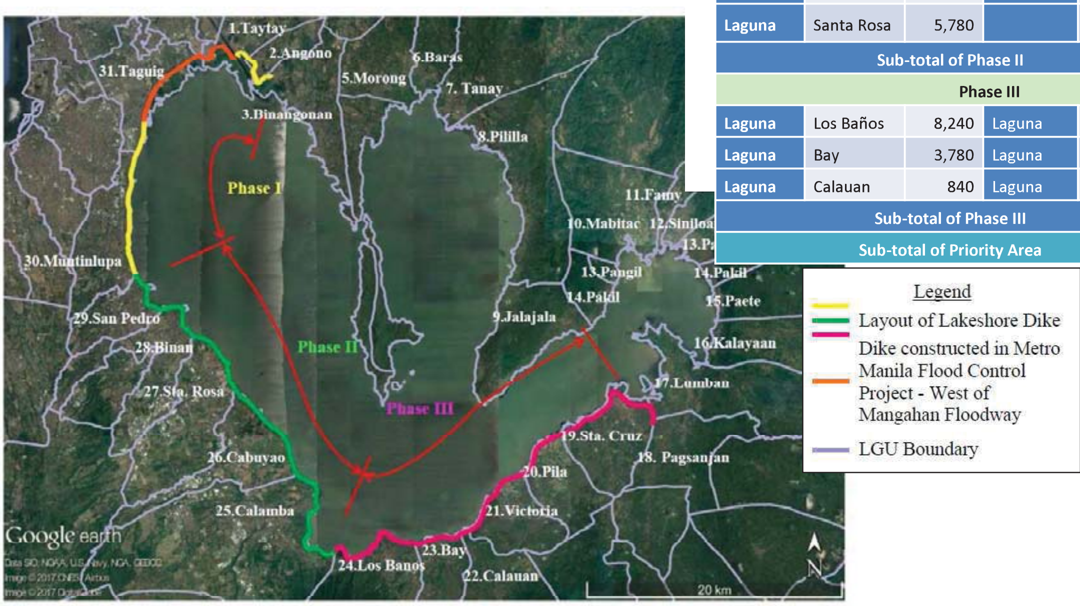
4.5 Study on Lakeshore Dike

2) Priority Area for Lakeshore Dike

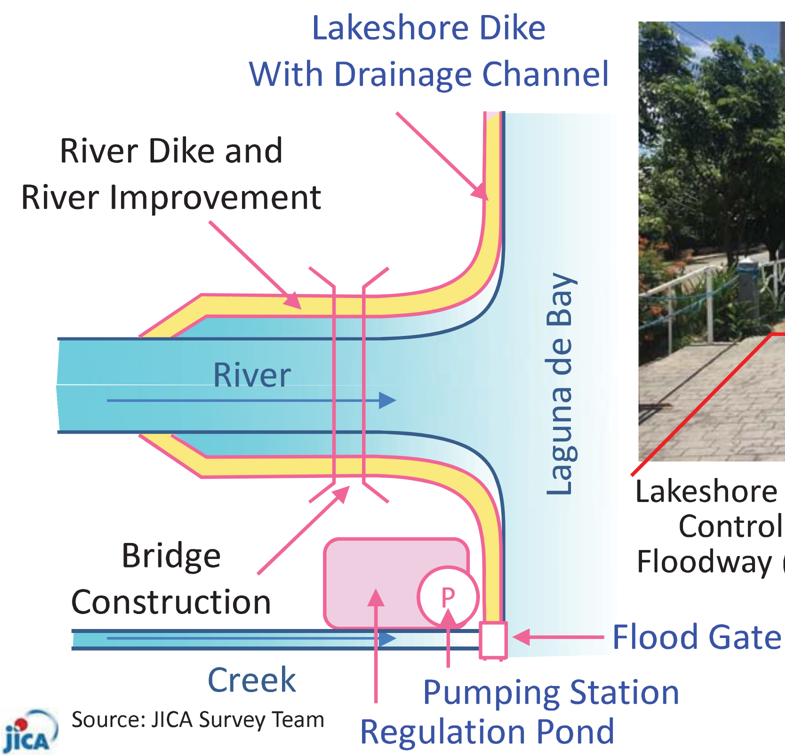
Place		Dike Length (m)	Place		Dike Length (m)
Province	LGU		Province	LGU	
Phase I					
Rizal	Angono	3,310	NCR	Taguig	2,490
Rizal	Taytay	1,350	NCR	Muntinlupa	9,870
Sub-total of Phase I					17,020
Phase II					
Laguna	San Pedro	4,080	Laguna	Cabuyao	8,390
Laguna	Biñan	4,660	Laguna	Calamba	9,920
Laguna	Santa Rosa	5,780			
Sub-total of Phase II					32,830
Phase III					
Laguna	Los Baños	8,240	Laguna	Victoria	6,470
Laguna	Bay	3,780	Laguna	Pila	4,750
Laguna	Calauan	840	Laguna	Santa Cruz	8,820
Sub-total of Phase III					32,900
Sub-total of Priority Area					82,750



Source: JICA Survey Team

4.5 Study on Lakeshore Dike

3) Concept of Lakeshore Diking System



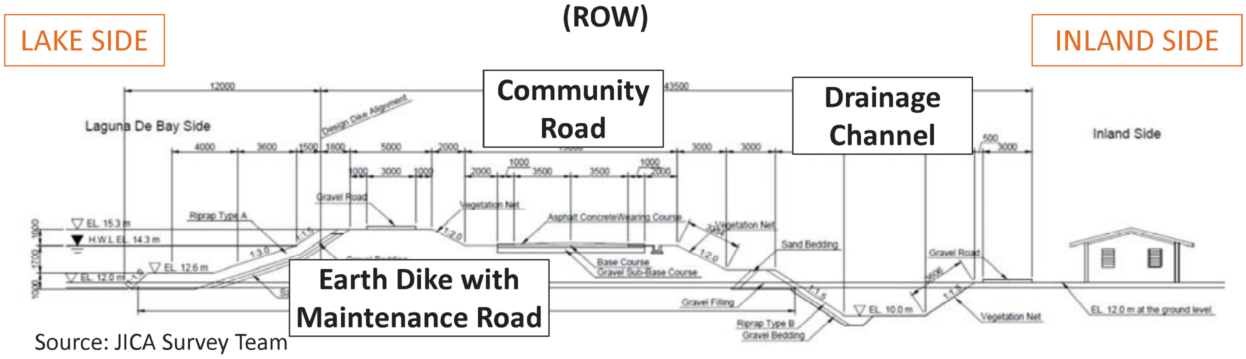
Lakeshore Dike at the Metro Manila Flood Control Project - West of Mangahan Floodway (after the additional Improvement)

Source: JICA Survey Team

4.5 Study on Lakeshore Dike

4) Construction of Lakeshore Dike (with drainage channel)

Typical Cross Section of the Lakeshore Dike



Source: JICA Survey Team

- ✓ The Lakeshore dike is proposed with a community road and a drainage channel referring to the structures in "the Metro Manila Flood Control Project - West of Mangahan Floodway."
- ✓ Community road has two lanes with shoulders.
- ✓ Drainage channel width and height are dependent on the Inflow.
- ✓ Proposing dike alignment at EL. 12m to EL. 12.5m to avoid residential areas

4.5 Study on Lakeshore Dike

5) Construction of Discharge Facility for Inland Flood

Pumping Station and Floodgate

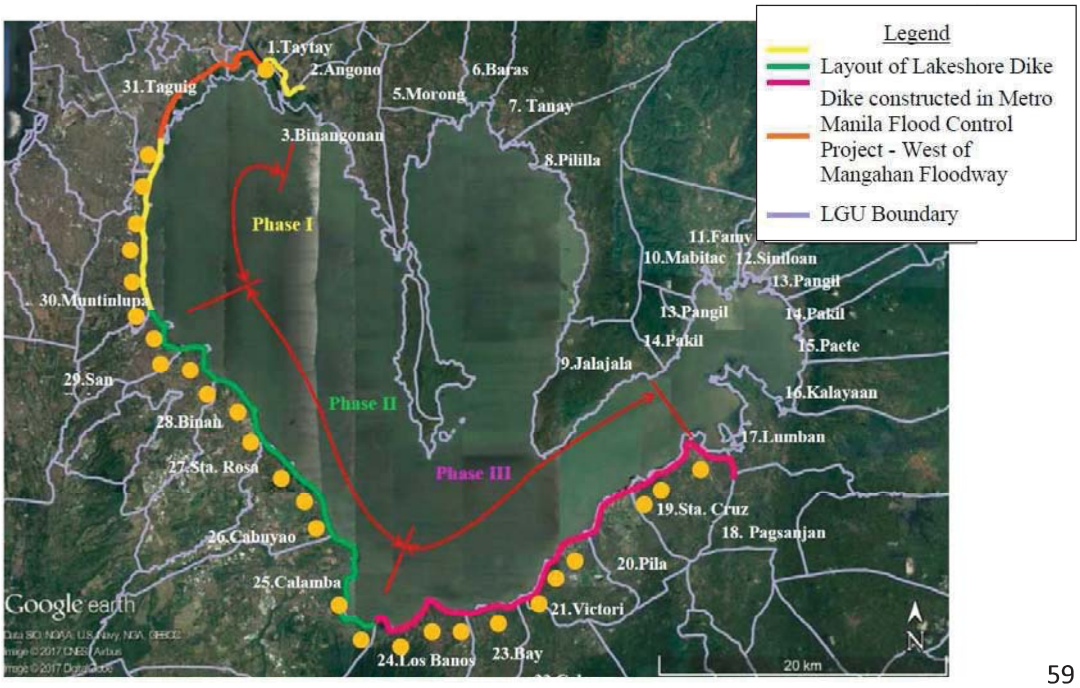
Source: the Metro Manila Flood Control Project - West of Mangahan Floodway

- ✓ Water from the creeks crossed by the Lakeshore dike is collected by the drainage channel along the dike and discharged into Laguna de Bay at the pumping station with flood gates.
- ✓ Discharge capacity of single pump and type of the pumps are referred to the ones of the existing pumps considering the maintenance.

4.5 Study on Lakeshore Dike

5) Construction of Discharge Facility for Inland Flood

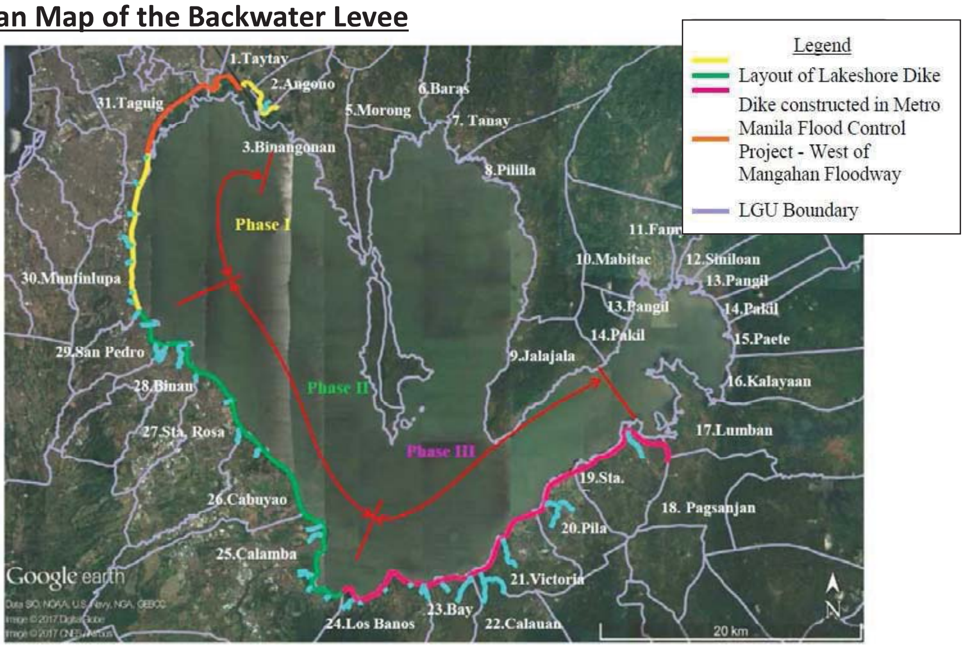
Pumping Station and Floodgate



4.5 Study on Lakeshore Dike

6) Construction of Backwater Levee

Plan Map of the Backwater Levee



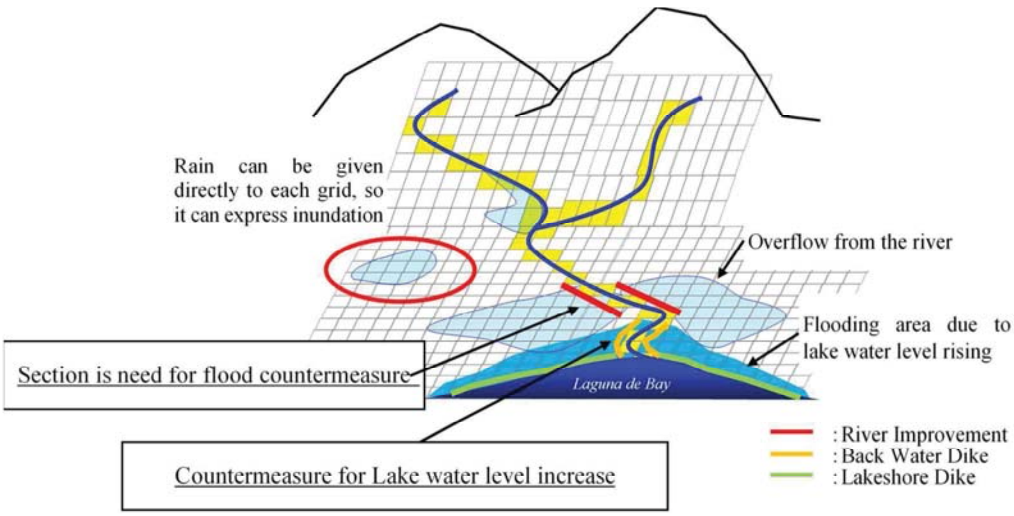
Source: JICA Survey Team

- ✓ Rivers are improved at the area affected by the surge of the water level at Laguna de Bay.

4.6 Study on Flood Countermeasure in Laguna Lake Basin

1) Study on Flood Countermeasure

- From the result of Runoff-Inundation Analysis for lakeshore area which is modelling in previous section (3.4.2), to organize the inundation area and assumed flood countermeasure (draft) in each watershed.
- The external forces targeted for flood control are "**Overflow Inundation**".



Source: JICA Survey Team

Figure 4.6.1 Concept of Flood Countermeasures in Laguna Lake Basin

4.6 Study on Flood Countermeasure in Laguna Lake Basin

2) River Basin Requiring Priority Flood Countermeasure for Overflow Flooding

- Basins are selected for priority flood countermeasure based on the result of RRI (Rainfall-Runoff-Inundation) analysis.
- Regarding the selection of the priority basin, it calculated the inundation area by the probability scale within basin, and affected population by flooding, and set river basin where affected population is more than 100,000 as the priority basin.

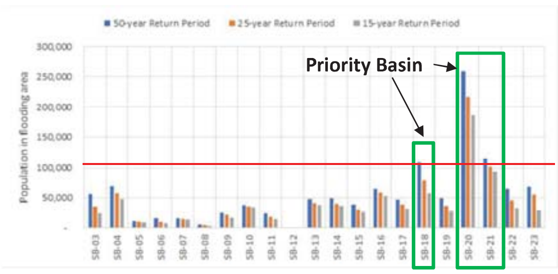
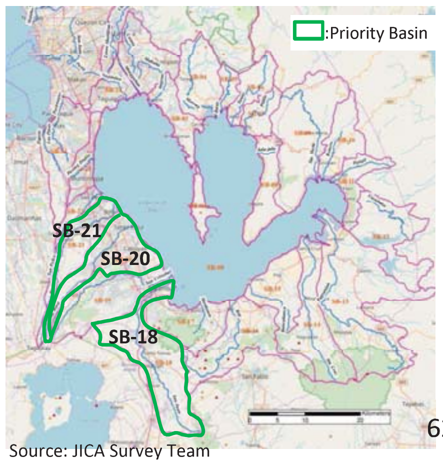


Table 4.6.2 Affected Population in Flooding Area

Table 4.6.1 Inundation Area and Affected Population in Each Probability

Sub-Basin ID	Sub-Basin Name	Sub-Basin Area km^2	Population in Sub-Basin	50-year Return Period		25-year Return Period		15-year Return Period	
				Inundation Area km^2	Population in flooding area	Inundation Area km^2	Population in flooding area	Inundation Area km^2	Population in flooding area
SB-03	Angono	86.60	427,916	9.61	56,420	6.53	34,595	4.56	25,101
SB-04	Morong	95.90	276,289	23.34	69,464	19.69	57,307	17.44	48,160
SB-05	Baras	21.70	30,710	3.18	12,084	2.41	10,050	1.95	8,668
SB-06	Tanay	52.20	45,091	7.92	15,867	6.11	10,323	5.36	8,203
SB-07	Pililla	40.40	50,411	5.66	15,822	4.86	14,891	4.22	13,820
SB-08	Jala-jala	70.60	60,941	5.36	5,513	3.26	3,938	2.14	2,801
SB-09	Sta. Maria	202.20	69,120	35.93	25,639	30.31	21,600	26.40	17,219
SB-10	Siniloan	71.70	55,274	17.19	36,973	15.06	35,003	13.39	33,502
SB-11	Pangil	50.10	36,740	10.52	24,629	8.73	19,174	7.27	15,467
SB-12	Caliraya	128.80	-	-	-	-	-	-	-
SB-13	Pagsanjan	301.20	166,744	48.88	47,931	39.62	41,554	33.54	37,684
SB-14	Sta. Cruz	146.70	206,362	18.56	49,731	14.03	40,322	11.28	36,199
SB-15	Pila	89.30	123,308	27.37	39,269	20.50	30,600	17.63	26,988
SB-16	Calauan	154.50	150,901	46.46	64,561	41.31	58,426	36.81	52,851
SB-17	Los Banos	102.10	223,840	19.00	47,166	14.92	39,007	12.46	32,009
SB-18	San Juan	191.70	438,646	44.56	108,670	34.10	78,360	27.36	57,842
SB-19	San Cristobal	140.60	390,420	15.27	49,535	10.77	36,468	7.98	27,516
SB-20	Sta. Rosa	119.80	659,121	41.04	259,047	34.54	216,869	29.77	186,105
SB-21	Binan	84.80	599,468	8.35	113,852	6.86	100,924	5.95	92,660
SB-22	San Pedro	46.00	386,193	5.15	64,614	3.58	45,854	2.53	33,005
SB-23	Muntinlupa	44.10	761,017	4.45	68,529	3.69	55,266	2.10	29,431



Source: JICA Survey Team

4.6 Study on Flood Countermeasure in Laguna Lake Basin

3) SB-18 San Juan Basin

- Total area of San Juan Basin is 191.7km^2 and some rivers are including in the basin. The result of inundation analysis of San Juan River, which is major river and design scale is 50-years.

River ID	River Name	Basin Area Km^2	River length Km	Design Scale	Design Discharge m^3/s	Assumed river improvement extension (km)
SB-18-1	San Juan	175.3	43.0	50	2,400	2.7
	Sub-total	175.3				
Total Basin	(Remaining Basin)	191.7 (16.4)				

＜Assumed Flood Countermeasure＞

<u>Backwater Levee</u>

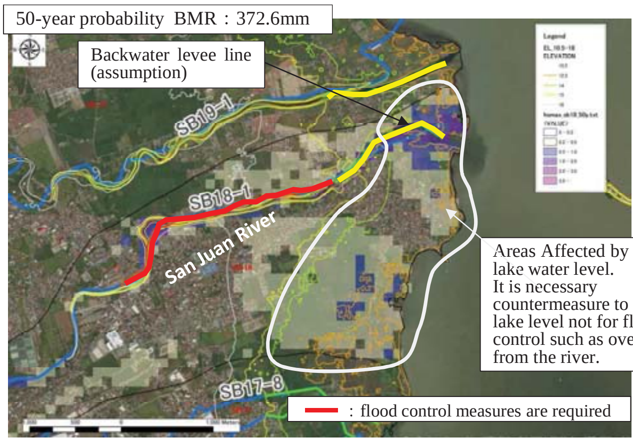
This area is proposed lakeshore dike and backwater levee will be constructed.

<u>Flood Countermeasures</u>

Residential areas are distributed particularly on the right bank side, and flooding area can be confirmed in some residential areas along rivers, overflow countermeasures are needed.

- River Improvement
  (River widening, Excavation)
- Dike

50-year probability BMR：372.6mm



4.6 Study on Flood Countermeasure in Laguna Lake Basin

3) SB-20 Sta.Rosa

- Total area of San Juan Basin is 191.7km^2 and some rivers are including in the basin. The result of inundation analysis of San Juan River.

River ID	River Name	Basin Area Km^2	River length Km	Design Scale	Design Discharge m^3/s	Assumed river improvement extension (km)
SB-20-1	Sta.Rosa	44.1	30.2	50	520	6.0
SB-20-2	Cabuyao	19.2	9.7	25	200	2.0
SB-20-3	Niugan	16.0	9.1	25	170	2.0
SB-20-4	Unknow	15.6	11.0	25	160	—
	Sub-total	94.9				
Total Basin	(Remaining Basin)	119.8 (24.9)				

＜Assumed Flood Countermeasure＞

<u>Backwater Levee</u>

This area is proposed lakeshore dike and backwater levee will be constructed.

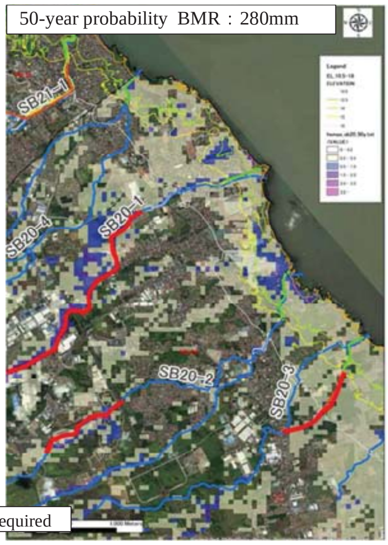
<u>Flood Countermeasures</u>

Residential areas are widely distributed, and flooded due to the influence of the lake level at lowland area.

Also, overflow countermeasure is necessary for middle section where flooding and houses are dense.

- River Improvement
  (River widening, Excavation)
- Dike

50-year probability BMR：280mm

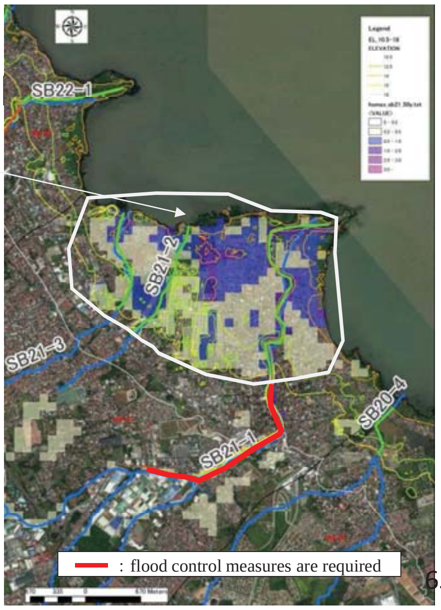


Source：Survey Team created based on Google Earth

3) SB-21 Binan

- Total area of Binan Basin is 84.8km2 and some rivers are including in the basin. The result of inundation analysis of Binan River, which is major river and design scale is 50-years.

River ID	River Name	Basin Area Km^2	River length Km	Design Scale	Design Discharge m^3/s	Assumed river improvement extension（km）
SB-21-1	Binan	67.7	36.0	50	700	2.5
	Sub-total	67.7				
Total Basin	(Remaining Basin)	84.8 (17.1)				



Areas Affected by rising lake water level.
It is necessary countermeasure to rising lake level not for flood control such as overflow from the river

＜Assumed Flood Countermeasure＞

Backwater Levee

This area is proposed lakeshore dike and backwater levee will be constructed.

Flood Countermeasures

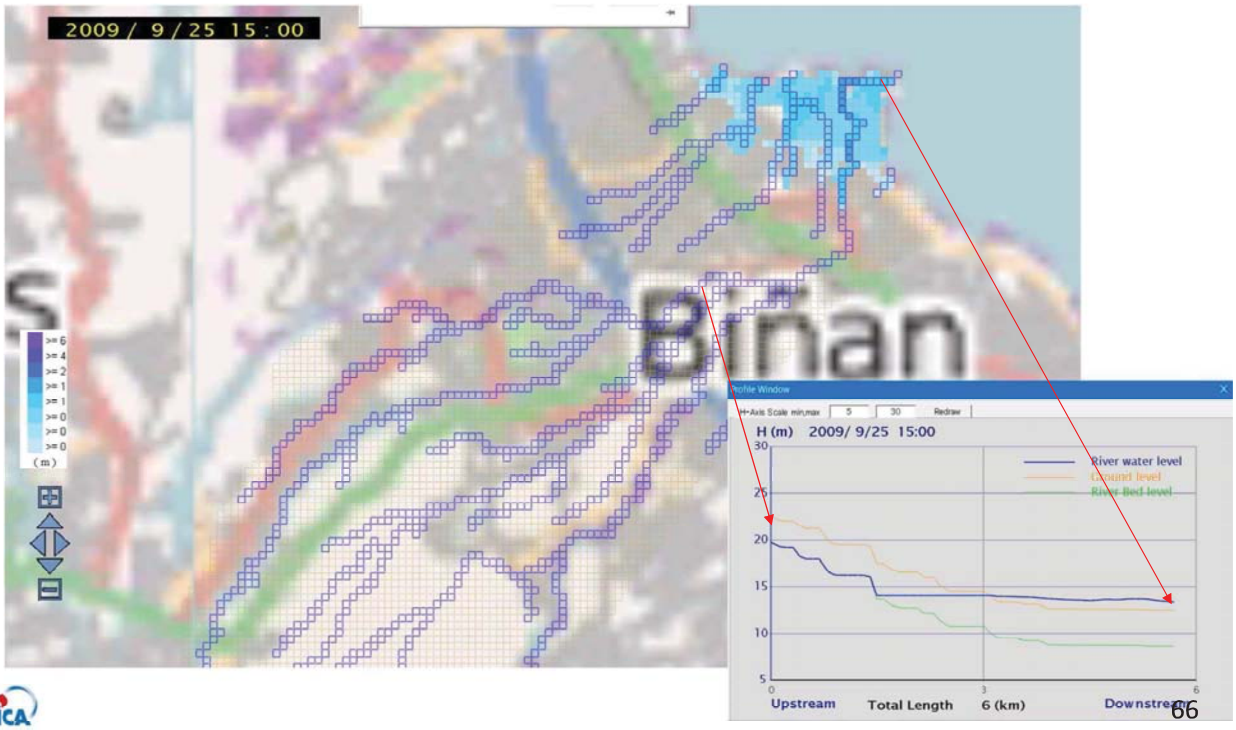
In the middle part of SB-21-1, due to flooding from the river, measures against overflow flooding are necessary.

- River Improvement (River widening, Excavation)
- Dike

Source：Survey Team created based on Google Earth

3) SB-21 Binan

- Animation of SB-21 50-year return period RRI analysis result



4.7 Non-structural Measures

1) Lakeshore Management

i) Insufficient Lakeshore Management

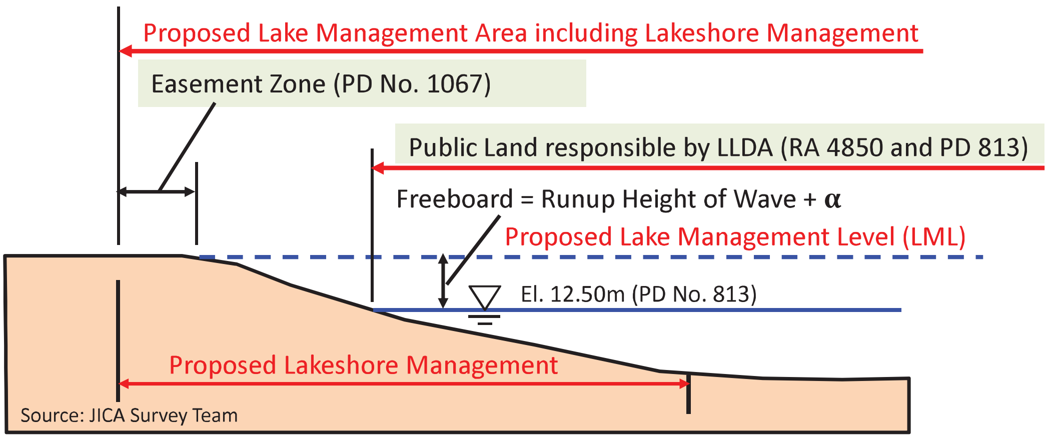
- RA No. 4850 (1966) and PD No. 813 state that Laguna Lake below El. 12.50m is public land for management by LLDA.
- El. 12.50m is the average of annual maximum lake water level and not the real lakeshore elevation.
- Lakeshore management below the real lakeshore elevation is insufficient.

ii) Proposal of Establishing Lakeshore Management System

- Set the lakeshore bank elevation : El. 12.50m + Wave runup height + **α**

  (Example: Wave runup height + **α** = 0.70m (half of freeboard 1.20m of the West Manggahan Dike) . Then, Lakeshore bank elevation = El. 13.20m (about 10-year return period of lake water level)
- Set easement zones from the Lakeshore bank (3m for urban area, 20m for agricultural area etc.).
- Manage between the easement zone to the other side of the Lake.
- Lakeshore management is to be conducted by LLDA under cooperation by LGUs and the related agencies (DPWH, DENR, DA etc.).

4.7 Non-structural Measures



Notes:
- Lake water level of El. 12.50m is average annual maximum lake level (based on the RA No. 4850 and PD No. 813)
- Easement zone: 3 m for urban area and 20 m for agricultural area (based on the PD No. 1067: Water Code)
- Freeboard example: 0.7m

Figure 4.7.1 Proposed Lakeshore Management Area for the Laguna de Bay

4.7 Non-structural Measures

2) DRRM Coordination Issue

i) Needs of Comprehensive Coordination of DRRM for the Entire Laguna Lake Basin

- The LGUs covering the Laguna Lake Basin belong to Region IV-A and NCR.
- Coordination between Region IV-A and NCR is rather difficult.
- Each related agency and LGU has different targets and plans related to DRRM.
- It is necessary to establish coordination system for DRRM for the entire Laguna Lake Basin for facing same direction of strengthening DRRM.

ii) Proposal of Comprehensive Coordination by NDRRMC for the Entire Laguna Lake Basin

- ➢ Coordination and monitoring progress of DRRM by NDRRMC is proposed (same as the proposal of the WB Master Plan in 2012).
- ➢ Based on the Master Plan for DRRM, DRRM is to be implemented for the entire Laguna Lake Basin with well-balanced manner.
- ➢ Propose to establish a Sub-committee under NDRRMC for the Laguna Lake Basin (better for Sub-committee for the Pasig-Marikina and Laguna Lake Basin) .

4.7 Non-structural Measures

3) Land Use Management

i) Importance of Land Use Management along the Laguna Lakeshore

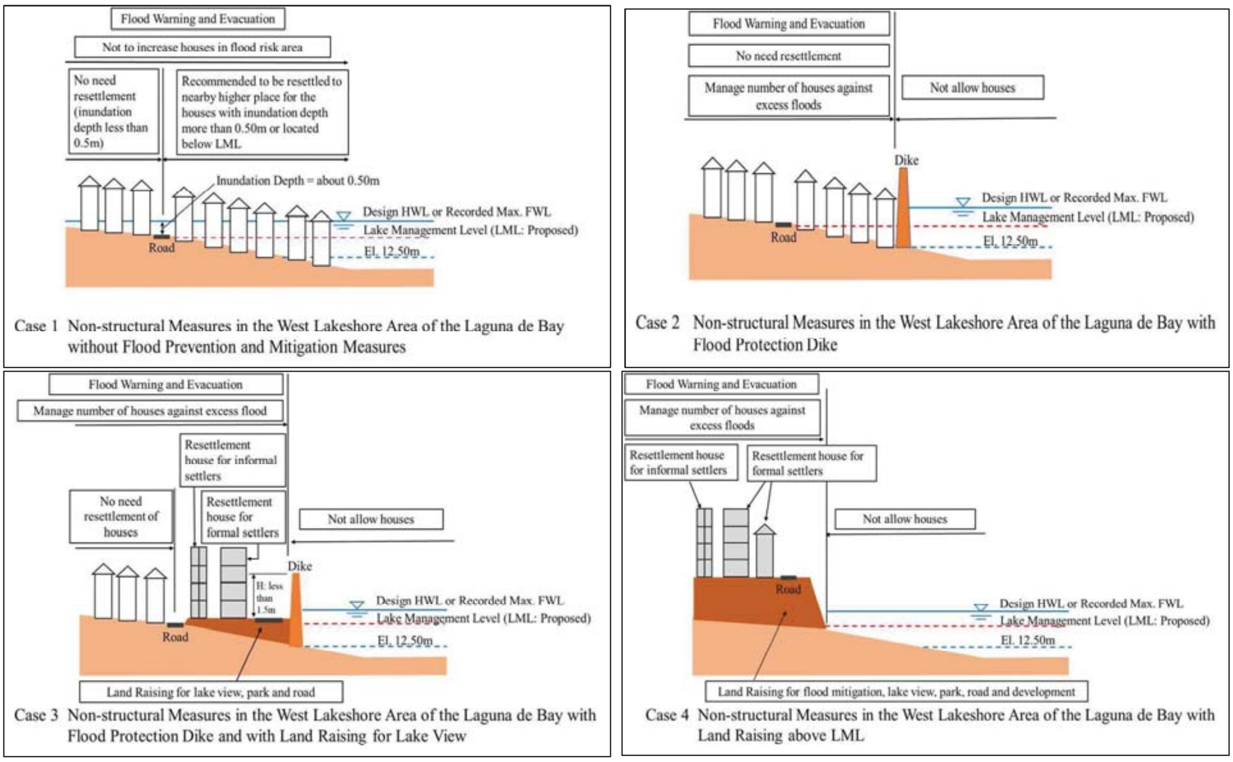
- Many houses exist in the low-lying areas with flood depth of more than 0.5m and with flood duration of 4 months by the 2009 and 2012 Floods.
- It is necessary not to allow houses in the above low-lying areas. However, it takes long time for resettle people in the low-lying areas to nearby higher safer places.

ii) Proposal of Land Use Management in the Low-lying Lakeshore Area in Combination with Flood Warning and Evacuation System

- ➢ Land Use Management in the low-lying lakeshore areas in combination of flood warning and evacuation for various cases are proposed.
- ➢ LGUs have desire to improve and develop the lakeshore area by considering the precious values of the Laguna de Bay such as beautiful scenery, natural environment and livelihood of fishermen*).

  *) Based on the interview by the Survey Team to OCD Region IV-A and LGUs including cities and municipality around the Lake. It is also necessary to consider the view points of LGUs for formulating flood control plan for the Lakeshore area.

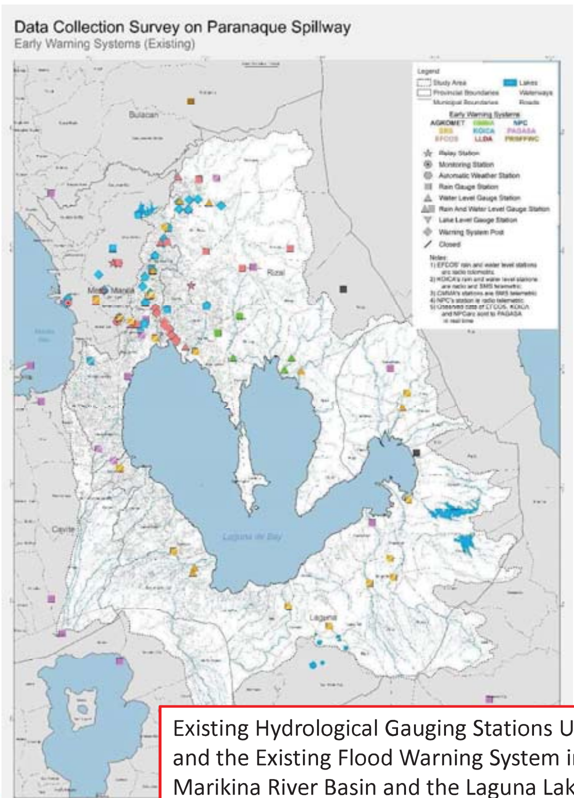
4.7 Non-structural Measures



Source: JICA Survey Team

Figure 4.7.2 Land Use Management for the Western Lakeshore Area of the Laguna de Bay

4.7 Non-structural Measures
4) Present Flood Warning System



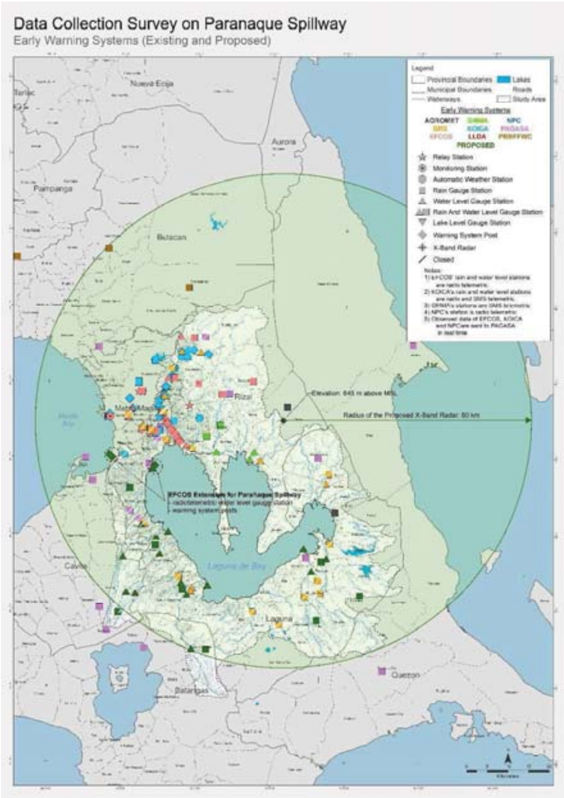
Existing Hydrological Gauging Stations Under-operation and the Existing Flood Warning System in the Pasig-Marikina River Basin and the Laguna Lake Basin.

Source: JICA Survey Team

i) Insufficient Flood Warning System

- PAGASA's radar rain gauge at Tagaytay (C-band radar with observation radius of about 120km) covers the Laguna Lake Basin and surrounding areas. However, this is not sufficient to catch local storm rainfall, which will cause flash floods in the tributary river basins in the Laguna Lake Basin.
- There is only pilot community-based flood warning system of GMMA Ready Project covering the Tanay River Basin and neighboring areas.
- Many LGUs have installed telemetric or manual gauging stations (rainfall and water level) for flood warning by themselves, but they are not connected to PAGASA's forecasting and warning systems.

4.7 Non-structural Measures
5) Proposed Flood Warning System



Source: JICA Survey Team

ii) Proposed Flood Warning System

PAGASA's Flood Warning System:

- X-band radar rain station (1 set) will be installed to catch flash floods in the tributary river basins of the Laguna Lake Basin.
- To install radio telemetric rain gauges (8 sets), float type water level gauges (8 sets) and float type water level gauges (15 sets) in the tributary river basins.

EFCOS Expansion for Operating the Parañaque Spillway

- Telemetric rain gauges (2 places)
- Telemetric water level gauges (2 places: 1 place in the Laguna de Bay inlet side and 1 place in the Manila de Bay outlet side of Parañaque Spillway.
- Warning posts to warn people (one each at inlet and outlet sides)

5. Comprehensive Flood Management Plan

5.1 Study on Combination of Flood Management Measures

5.2 Implementation Schedule

5.3 Preliminary Cost Estimation

5.4 Study on Project Effectiveness

5.5 Proposed Organization for Project Implementation/Operation, Maintenance and Management

5.1 Study on Combination of Flood Management Measures

Selected Flood Management Measures

Water Level Rise Control	Inundation Damage Reduction	Non-Structural Measures
· Construction **of Parañaque Spillway**	· Construction of the **Lakeshore Diking System** (includes the installation of drainage channel, Pumping Station, Backwater Levee, etc.)	· Implementation of the lakeshore management · Establishment of the committee for the Laguna de Bay Basin · Land use regulation · Implementation of warning system · Inundation hazard map

Study on Combination of Flood Management Measures

Case	Objectives	Structural Measures	Non-Structural Measures
A	Prevention of Flood Damage	· Construction of **Lakeshore Diking System** at the Priority Area	· Implementation of the lakeshore management · Establishment of the committee for the Laguna de Bay Basin · Land use regulation · Implementation of warning system · Inundation hazard map
B	Mitigation of Flood Damage	· Construction of **Parañaque Spillway**	
C	Prevention of Flood Damage	· Construction of **Lakeshore Diking System** at the Priority Area · Construction of **Parañaque Spillway**	

Case A: Priority Area will be protected by the **Lakeshore Diking System** to the 100-year probable lake water level. The residual area will be also protected with a warning system.

Case B: Although total protection to the flood caused by 100-year probable lake water level cannot be provided, flood mitigation such as reduction of the inundation depth and period can be made by **Parañaque Spillway**.

Case C: The height of the lakeshore dike can be lowered considering the water level drawdown by the **Parañaque Spillway**. With combined operation of the Parañaque Spillway, Priority Area will be protected by the **Lakeshore Diking System** to the 100-year probable lake water level. The residual area will be also protected with a warning system.

5.1 Study on Combination of Flood Management Measures

Results of Study on Combination of Flood Management Measures

Criteria	Index	Case A	Case B	Case C
Structural Measures		· Construction of Lakeshore Diking System at Priority Area	· Construction of Parañaque Spillway	· Construction of Parañaque Spillway · Construction of Lakeshore Diking System at Priority Area
Design Return Period		· 100-year Return Period	· 100-year Return Period	· 100-year Return Period
Design Lake Water Level		· 14.3m	· 14.0m (Effect of PSW)	· 14.0m (Effect of PSW)
1. Management of Disaster Risk	(1) Drawdown of Water Level	· No effect	· By 0.3m **from 14.3m** (100-year return period) **to 14.0m**	· Same as Case B
	(2) Reduction of Inundation Area	· Phase 1 : 570 ha · Phase 2 : 1,490 ha · Phase 3 : 2,580 ha · Total : **4,640 ha**	· Although the spillway cannot prevent the flood damage at 100%, following flood damage mitigation can be achieved at the entire lakeshore areas. · Area : **7,720 ha**	· Same as Case B after completion of Spillway and before completion of lakeshore dike. · No inundation after completion of lakeshore dike at the phase 1, 2 and 3 areas.
	(3) Reduction of affected People	· Phase 1 : 145,000 · Phase 2 : 257,000 · Phase 3 : 91,000 · Total : **493,000**	· Although the spillway cannot prevent the flood damage at 100%, flood damage mitigation is expected for the following people at the entire lakeshore areas. · Total : **624,000**	· Same as Case B after completion of Spillway and before completion of lakeshore dike. · No inundation after completion of lakeshore dike at the phase 1, 2 and 3 areas.
	(4) Reduction of Inundation Period	· No inundation after completion of lakeshore dike at the phase 1, 2 and 3 areas.	· In case of 100-year probable flood, inundated days with the lake water level of **EL 12.5 m** or above can be shortened from 124 days to 79 days (64%) at the entire lakeshore areas.	· Same as above

5.1 Study on Combination of Flood Management Measures

Results of Study on Combination of Flood Management Measures

Criteria	Index	Case A	Case B	Case C
2. Technical Issue	(1) Design	・No difficulty on designing since it is mainly composed of earth dike.	・Although it is a large scaled tunnel and an underground structure at 50 m or deeper with technical difficulties, it is feasible with know-how and experiences in Japan.	・Same as the evaluation in Case A and B
	(2) Necessary Steps of Administration Process before Construction	・This case results in constructing the wall with a little less than 3 m high and it will limit the access to the lake from the land side. It is expected that it takes time for negotiation and consensus building with fishermen and residents. ・Land acquisition and relocation will be required.	・Less social impact such as relocation and consensus building since it is designed deep underground at 50 m ・Relocation and consensus building will be required at the inlet and outlet of the spillway.	・It is realistic that the spillway which has relatively less difficulty on administration processes is commenced first, then the lakeshore dike which requires more time for those is commenced later.
	(3) **Year of Completion**	・Phase 1 : **yr 2029** ・Phase 2 : **yr 2039** ・Phase 3 : **yr 2049**	・**yr 2030**	・Same as the evaluation in Case of A and B
	(4) Influence to **Existing Structures**	・Design high lake water level is **EL. 14.3 m**, crown elevation of the lakeshore dike is EL 15.3 m, crown elevation of the dikes of Mangahan Floodway at the lake side is **EL. 15.0 m**. ・Dike at **Mangahan Floodway** need to be elevated by **30 cm**. ・The crest elevation of the **West Mangahan Lakeshore Dike** is also **EL 15.0 m** and need to be elevated by **30 cm**.	・Design high lake water level is **EL. 14.0 m**, crown elevation of the lakeshore dike is **EL 15.0 m**. ・No influence on the existing structure and plan	・Design high lake water level is EL. 14.0 m, crown elevation of the lakeshore dike is EL 15.0 m. ・No influence on the existing structure and plan

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5.1 Study on Combination of Flood Management Measures

Results of Study on Combination of Flood Management Measures

Criteria	Index	Case A	Case B	Case C
3. Flood Exceeding Design Level, Climate Change Adaptation	(1) Adaptation to Extreme Flood	・**The free board** of the lakeshore dike is utilized for the lake water level rise.	・**The spillway shows the effect to extreme flood**. ・The spillway lowers the water level of **14.7m** in **200-year return period** by **0.4m** and reduces the inundation period with water level at EL. 12.5 and above from 141 days to 93 days (66%).	・Sufficient effect can be expected with the lake water level lowering effect by the spillway and the free board of the lakeshore dike.
	(2) Adaptation to Climate Change	・The free board of the lakeshore dike is utilized for the lake water level rise.	・It is estimated that the water level rises to **14.6m from 14.3m** with heavier rainfall by **climate change**. The spillway can lower the water level under this environment by 0.3m.	・Sufficient effect can be expected with the lake water level lowering effect by the spillway and the free board of the lakeshore dike.
4. Natural Environment	(1) Lakeshore landscape preservation	・This case results in constructing the wall with a little less than 3 m high and it will limit the access to the lake from the land side. Some disturbance on the landscape can be expected.	・No significant impact due to the construction of inlet of the spillway at the lake side.	・Same as the evaluation in Case A and B
5. Social Environment	(1) Resettlement	・Although the lakeshore dike will be constructed at the lower area than EL 12.5 m, there are some relocation. ・Lakeshore dike : **7,200** ・Backwater levee: **4,400**	・Some resettlement will be required at the inlet and the outlet of the spillway.	・Same as the evaluation in Case A and B
	(2) Land Acquisition	・Although the lakeshore dike will be constructed at the lower area than EL 12.5 m, there are some relocation. ・Lake shore dike : **1,100 ha** ・Backwater levee: **120 ha**	・Some resettlement will be required at the inlet and the outlet of the spillway.	・Same as the evaluation in Case A and B

JICA

5.1 Study on Combination of Flood Management Measures

Results of Study on Combination of Flood Management Measures

Criteria	Index	Case A	Case B	Case C
6. Operation and Maintenance	(1) Difficulty of Operation and Maintenance, **O/M Cost**	· General structure. No special concern on maintenance. · O/M Cost: **PHP 280.0 mil.**	· Although it is a large scaled tunnel and an underground structure at 50 m or deeper with technical difficulties, it is feasible with know-how and experiences in Japan. · O/M Cost: **PHP 210.7 to 278.3 mil.**	· Same as the evaluation in Case A and B · O/M Cost for lakeshore dike: **PHP 265.4 mil.** · O/M Cost for Spillway: **PHP 210.7 to 278.3 mil.** · Total: **PHP 476.1 to 543.7 mil.**
7. Financial Feasibility	(1) Construction Cost	· **PHP 45.7 bln.**	· **PHP 36.2 to 49.1 bln**	· Lakeshore dike: PHP 42.1 bln. · Spillway: PHP 36.2 to 49.1 bln. · Total: **PHP 78.2 to 91.2 bln.**
	(2) Project Cost including Compensation Cost	· **PHP 94.2 bln.**	· **PHP 55.4 to 74.6 bln**	· Lakeshore dike: PHP 87.5 bln. · Spillway: PHP 55.4 to 74.6 bln. · Total: **142.9 to 162.1 bln.**
8. Economic Analysis	(1) Annual Average Flood Damage Reduction	· Phase 1 : PHP 1.48 bln. · Phase 2 : PHP 1.79 bln. · Phase 3 : PHP 1.06 bln. · Total : **PHP 4.33 bln.**	· at the entire lakeshore areas · Total : **PHP 3.23 bln.**	· Same as Case B after completion of Spillway and before completion of dike. · No inundation after completion of lakeshore dike at the phase 1, 2 and 3 areas.
	(2) Benefit of Improvement of Transportation	· Phase 1: PHP 0.30 bln. · Phase 2: PHP 0.58 bln. · Phase 3: PHP 0.27 bln. · Total : **PHP 1.15 bln.**	· -	· Same as Case A after completion of dike.
	(3) EIRR (B/C)	· Flood: **13.5% (1.36)** · Flood + Road: **15.9 %(1.65)**	· **8.2 (0.78) to 10.3% (1.04)**	· **8.8 (0.86) to 10.7% (1.08)**

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5.1 Study on Combination of Flood Management Measures

Results of Study on Combination of Flood Management Measures

The **Lakeshore diking system** requires

1) a large number of relocation of local people including ISFs,
2) land acquisition with the influence on the fishery at Laguna de Bay, and
3) a long period of construction such as 20 years to 30 years.

On the other hand, the **Parañaque Spillway**

1) has a feature to provide the flood mitigation effect to the entire lakeshore area evenly.
2) needs the construction period of about 10 years, so that the early mitigation effect can be expected.
3) mitigates extreme flood and flood damage from climate change.

Hence, it is presently considered to be appropriate to construct the **Parañaque Spillway** as the **priority project** and then to implement the **Lakeshore diking system** as the long-term project.

Based on the evaluation result, "**Case C: Construction of the Lakeshore Diking System at the Priority Area and Construction of the Parañaque Spillway**" was selected as a composition of "**Comprehensive Flood Management Plan of Laguna de Bay Lakeshore Area**."

In addition, among these structural components of the flood management plan, "**Construction of the Parañaque Spillway**" was selected as **priority project.**

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5.2 Implementation Schedule

1) Planning Condition

Implementation Schedule is considered in three Phases.

【Phase１】 Jan. 2020 to Dec. 2029

a. Parañaque Spillway （Route A　L=7.8km,Route D L=9.6km)

Option1: Route A, Shield Tunneling Method

Option2: Route A, NATM

Option3: Route D, Shield Tunneling Method

Option4: Route D, NATM

b. Lakeshore Diking Systems (L=17.02km)

c. Expansion of EFCOS

【Phase2】 Jan.2030 to Dec.2039

d. Lakeshore Diking Systems (L=32.83km)

【Phase3】 Jan.2040 to Dec.2049

e. Lakeshore Diking Systems (L=32.90km)

5.2 Implementation Schedule

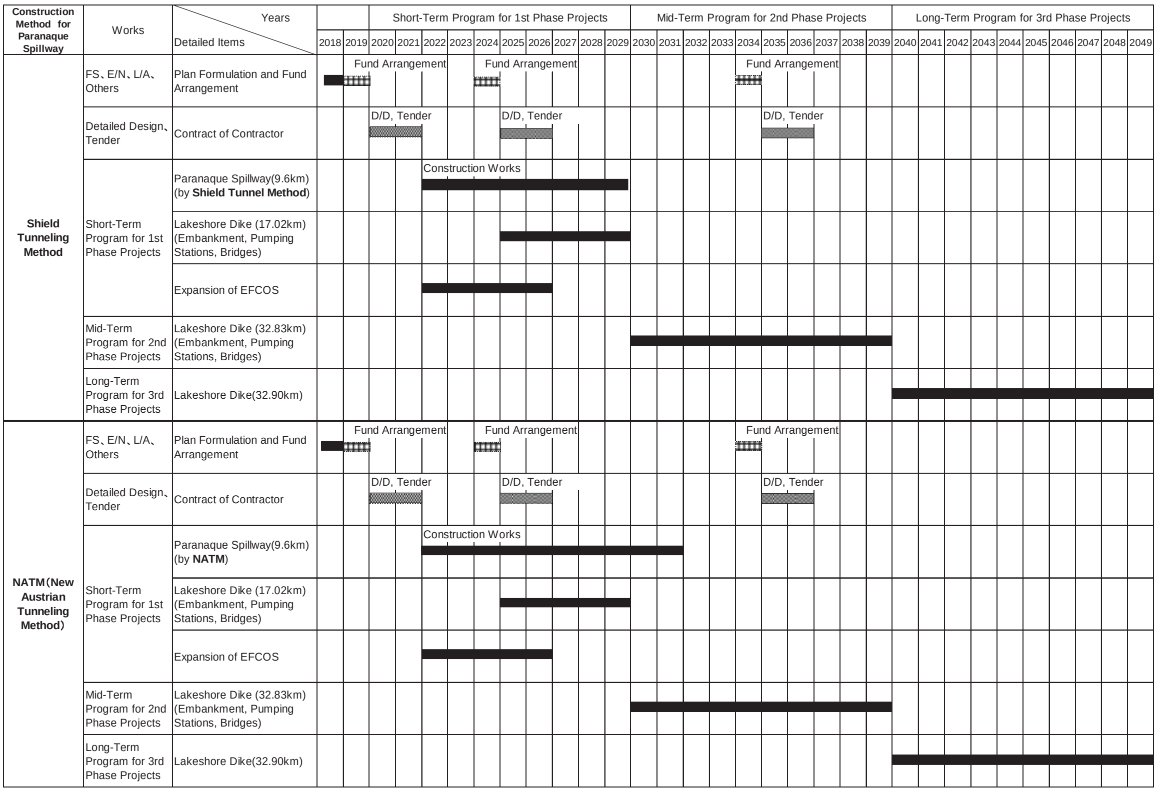
2) Implementation Schedule (Parañaque Spillway : Route A)

Years: 2018–2049. Short-Term Program for 1st Phase Projects (2020–2029); Mid-Term Program for 2nd Phase Projects (2030–2039); Long-Term Program for 3rd Phase Projects (2040–2049)

Construction Method for Paranaque Spillway	Works	Detailed Items	
Shield Tunneling Method	FS、E/N、L/A、Others	Plan Formulation and Fund Arrangement	Fund Arrangement; Fund Arrangement; Fund Arrangement
	Detailed Design、Tender	Contract of Contractor	D/D, Tender; D/D, Tender; D/D, Tender
	Short-Term Program for 1st Phase Projects	Paranaque Spillway(7.8km) (by **Shield Tunnel Method**)	Construction Works
		Lakeshore Dike (17.02km) (Embankment, Pumping Stations, Bridges)	
		Expansion of EFCOS	
	Mid-Term Program for 2nd Phase Projects	Lakeshore Dike (32.83km) (Embankment, Pumping Stations, Bridges)	
	Long-Term Program for 3rd Phase Projects	Lakeshore Dike(32.90km)	
NATM（New Austrian Tunneling Method）	FS、E/N、L/A、Others	Plan Formulation and Fund Arrangement	Fund Arrangement; Fund Arrangement; Fund Arrangement
	Detailed Design、Tender	Contract of Contractor	D/D, Tender; D/D, Tender; D/D, Tender
	Short-Term Program for 1st Phase Projects	Paranaque Spillway(7.8km) (by **NATM**)	Construction Works
		Lakeshore Dike (17.02km) (Embankment, Pumping Stations, Bridges)	
		Expansion of EFCOS	
	Mid-Term Program for 2nd Phase Projects	Lakeshore Dike (32.83km) (Embankment, Pumping Stations, Bridges)	
	Long-Term Program for 3rd Phase Projects	Lakeshore Dike(32.90km)	

5.2 Implementation Schedule

3) Implementation Schedule (Parañaque Spillway : Route D)



5.3 Preliminary Cost Estimate

1) Items on Project Cost

a. Construction Cost

b. Engineering Cost (the cost for consulting service) ; 10% of Construction Cost

c. Price Escalation; FC 0.8% , LC 1.8%

d. Contingency; 10% of total amount for Construction Cost , Engineering Cost and Price Escalation

e. Land Acquisition and Compensation

f. Project Administration Cost; 2% of total amount for Construction Cost, Engineering Cost and the cost for Land Acquisition and Compensation

g. VAT; 12%

5.3 Preliminary Cost Estimate

2) Project Cost

Cost Items	Work Items	Project Cost (million Peso)			
		Option 1	Option 2	Option 3	Option 4
Construction Cost	Parañaque Spillway Option 1: Route A, Shield Option 2: Route A, NATM Option 3: Route D, Shield Option 4: Route D, NATM	45,876	36,148	49,121	37,653
	Lakeshore Diking Systems	42,073	42,073	42,073	42,073
	Expansion of EFCOS	114	114	114	114
	Sub-Total	88,063	78,335	91,308	79,840
Engineering Cost		8,806	7,833	9,131	7,984
Price Escalation		11,732	10,611	12,140	10,826
Contingency		20,449	19,944	20,964	20,435
Land Acquisition, Compensation		8,786	8,786	8,786	8,786
Administration Cost		2,757	2,510	2,847	2,557
VAT (12%)		16,540	15,061	17,080	15,345
Total (million Peso)		157,133	143,082	162,255	145,773

5.4 Study on Project Effectiveness

Outline of Economic Analysis

Quantified Economic Cost and Economic Benefits

Project Cost	Economic Benefits
(1) Initial Construction Cost (2) O&M Cost (3) Major Rehabilitation Cost	(1) Reduced Economic Damage caused by Inundation (household assets, commercial/industrial assets, infrastructure, agriculture crops, suspension of economic activities) (2) Improvement of Transportation (3) Increase of Land Price

Annual average value of "(1)Reduced economic damage induced by inundation" is calculated by multiplying the "avoided damage of assets/human life under different return period cases (2, 3, 5, 10, 20, 30, 50, 100, 200 years)" and "occurrence rate of each cases per year".

5.4 Study on Project Effectiveness

Methodology of Calculation of Economic Damage caused by Inundation

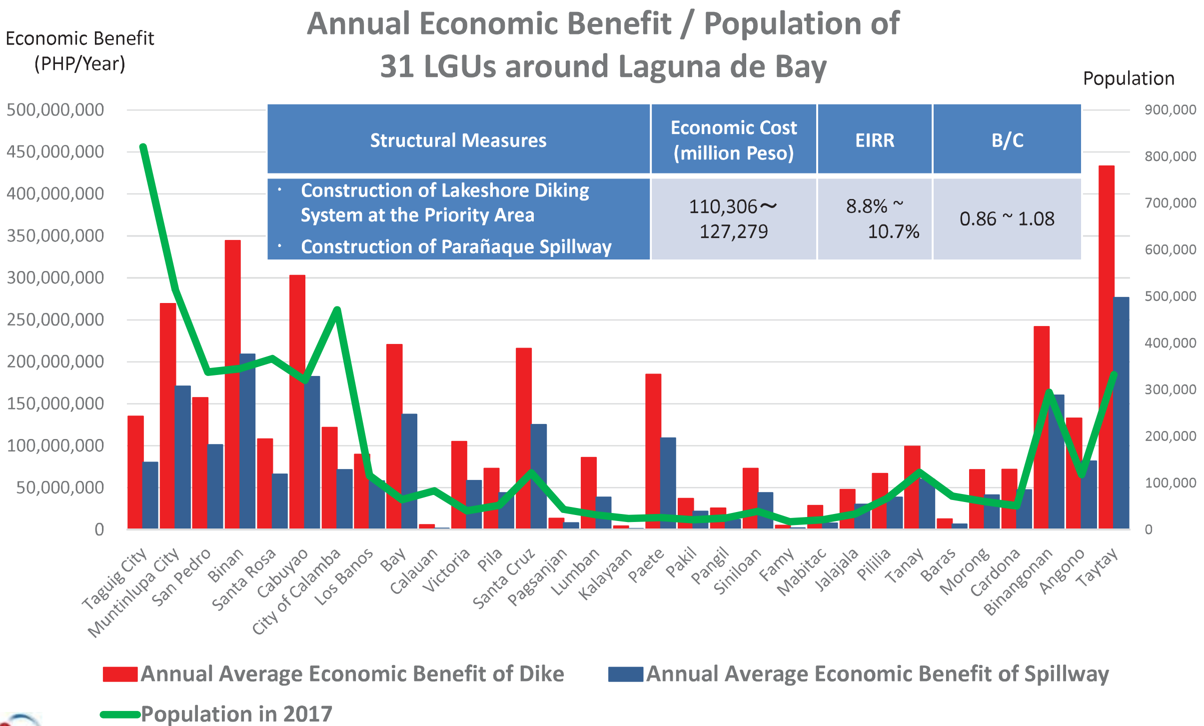
Economic Damage	Formula
• Damage of Household Assets	"Number of Affected Household (affected population / average household size)" x "Value of Household Assets" x "Damage Rate" x 1.3 (including indirect damage)
• Damage of Commercial and Industrial Assets	"Number of Affected Enterprises" x "Value of Commercial Assets" x "Damage Rate" x 1.3 (including indirect damage)
• Damage of Agricultural Crops (Paddy, Maize, commercial crops)	"Affected Area of Crops" x "Economic Value of Agricultural Crops per hectare" x "Damage Rate"
• Avoided Economic Cost of Suspended Business Activities	"Number of Affected Enterprises" x "Reduced Period of Suspension" x "Average Daily Added Value per Enterprise"

Methodology of Calculation of Other Economic Benefits

Economic Benefit	Formula
• Benefit of Improvement of Transportation	"Unit cost of VOC per vehicle category (PHP/km)" x "Total Distance per vehicle category (km)" "Total Saved Time" x "Value of Saved Time"
• Benefit of Increase of Land Price	"Influenced Area" x "Current Market Value of Land" x "Increase Rate of Land Value"

5.4 Study on Project Effectiveness

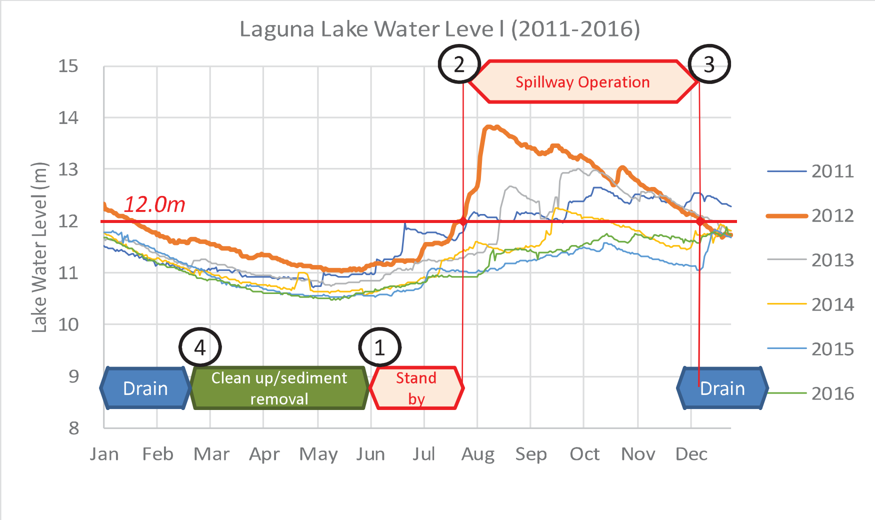
Result of Economic Benefit (Reduced Damage) caused by Inundation



Structural Measures	Economic Cost (million Peso)	EIRR	B/C
• Construction of Lakeshore Diking System at the Priority Area • Construction of Parañaque Spillway	110,306～127,279	8.8% ~ 10.7%	0.86 ~ 1.08

5.5 Proposed Organization for Project Implementation/Operation, Maintenance and Management

Example of General Schedule of O&M for Parañaque Spillway (Case Study for CY2012)



① Stand-by
② Start spillway operation (when Lake WL >12.0m)
③ Finish spillway operation (when Lake WL <12.0m), and start drain from tunnel
④ Start clean up of underground tunnel after completion of drainage
⑤ Stand by

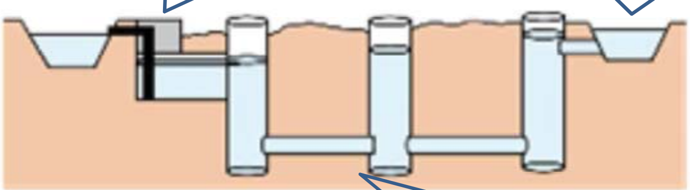
5.5 Proposed Organization for Project Implementation/Operation, Maintenance and Management

Pump House

- ✓ Outlet Gate/Pump Operation
- ✓ Removal of garbage/sediment at outlet
- ✓ Maintenance & repair of hydro-electric, mechanical equipment

Intake/Inlet

- ✓ Intake Gate Operation
- ✓ Removal of garbage/sediment at inlet
- ✓ Maintenance & repair of intake facilities



Underground Tunnel

- ✓ Gate/Pump Operation for drainage from tunnel
- ✓ Cleaning and ventilating of tunnel
- ✓ Removal of sediments
- ✓ Inspection/Rehabilitation of tunnel

Ex. Annual O&M Cost
Kan-nana Underground Storage in JAPAN in 2016 [L=4.5km, D=12.5m]

Clean up of tunnel	P45 Mil./y	43.6%
Maintenance of Mechanical Works	P30 Mil./y	28.0%
Fuel/Electricity	P30 Mil./y	28.4%
Total	P105 Mil./y	100%
	(0.22% of Project cost)	

5.5 Proposed Organization for Project Implementation/Operation, Maintenance and Management

Proposal for Organization
for Comprehensive Flood Control Works in Laguna de Bay

Flood Control Works	Outline	Implementation	Operation and Maintenance
Spillway	Underground tunnel spillway (L7.8-9.8km, drainage pump facilities)	DPWH-UPMO	· DPWH-UPMO/MMDA
Lake Dike	Crest EL.14.0m, total length 83km	DPWH-UPMO	· MMDA-FCSMO (in Metro Manila) · DPWH-RO/DEOs or LGUs (other areas) · Land management for relating structures by LLDA/LGUs
Pump Station	28 pump stations in the low lying area of lake dike	DPWH-UPMO	
River Improvements	Major tributaries in the consruction areaof lake dike	DPWH-UPMO	

- ✓ The responsibility of O&M is going to be shared among several organizations in the regular case, however it is not effective to manage
- ✓ Since the measures to be proposed are the large-scale structures, it is appropriate to establish the project implementation/operation and maintenance system by positioning DPWH in center.

6. Preliminary Environmental and Social Analysis

6.1 Existing Conditions of Target Areas

6.2 Potential Impacts of Parañaque spillway

6.3 Potential Impacts of (1) Lakeshore Dike, (2)Backwater Levee and (3)Drainage Facility (Pumping Station)

6.4 Considerations necessary for Major Potential Impacts

6.5 Impact on Manila Bay Environment

6.1 Existing Conditions of Target Areas

Salient Features on Environmental and Social Baseline

Category	Elements	Current Status / Features
Natural Environment	Terrestrial Ecology	• Vegetation and wildlife habitats are affected by human activities around Laguna Lake. • There is no primary forests, or wildlife sanctuary.
	Ecology of Laguna Lake	• Lake is featured with diminishing biodiversity, and algal bloom. • Even though, the lake still has rich natural resources. (e.g., 31 fish species: data of LLDA).
	Protected Area	• LPPCHEA (Las Piñas-Parañaque Critical Habitat and Ecotourism Area) in Manila Bay • Fish sanctuaries in Laguna Lake designated by LLDA
Social Environment	Informal Settle Families (ISFs)	• Large number of ISFs in lakeshore of Laguna Lake and dangerous area (along rivers) and delayed progress of relocation.
	Economic Activity in Laguna Lake	• Wide range of economic activities in Laguna Lake: Fishery (open lake fishing and fish culture), water intake for irrigation, domestic water supply, hydropower generation, water transportation, etc.
	Groundwater use	• Deepwells along candidate location of Parañaque Spillway
Public Pollution	Air Quality / Noise	• TSP (Total Suspended Particles), PM_{10}: Beyond DNER standard in NCR, • Noise level: Beyond standard value in both NCR and Laguna Province
	Water Quality	• Laguna Lake: Within DENR standard in the lake but beyond for inflow rivers in urban areas, • Manila Bay: Beyond DENR standard with huge coliform counts due to untreated waste water

6.2 Potential Impacts of Parañaque spillway

Construction of Parañaque Spillway

Pre-Construction Stage

- **Land acquisition** for (1) Intake facility, (2) Drainage facility and (3) Underground spillway.
- (1) Intake facility: difficult to identify the available land in densely populated area in NCR.
- (2) drainage facility: **Relocation of ISFs** on the candidate site is required.
- (3) Underground spillway: no need of compensation in case of **deeper than 50m.** (RA No. 10752)

Construction Stage

- **Traffic disturbance** due to transportation of construction equipment (segment for tunnel lining) and excavated materials: 900 no./day of trailers/dump trucks.
- **Disposal of excavated materials** from tunneling (1.4 to 1.8 million m3) and development of backfill site.
- Potential impact on groundwater use from deepwells.

Operation Stage

- Impact on **water quality in Manila Bay** due to water discharge from spillway.
- Impact on **LPPCHEA** (Protected Area: Ramsar Site), especially on aquatic ecology and wild birds due to water discharge from spillway.

6.3 Potential Impacts of (1) Lakeshore Dike, (2)Backwater Levee and (3)Drainage Facility (Pumping Station)

Lakeshore Dike, River Channel Improvement and Drainage Facilities

Pre-Construction Stage

- **Land acquisition** for ROW of project facilities: 1,280 ha (in priority areas I, II III)
- **Resettlement**: estimated at 11,500 PAPs (ditto)
- **Compensation** Cost: PhP. 6,700 million (ditto)

Construction Stage

- **Traffic disturbance** due to transportation of earth materials for dike construction, etc. : 450 dump trucks /day
- **Generation of solid wastes** due to demolition of existing structures and facilities: approx. 2,910 buildings (in priority areas I, II, III)
- Impact on **economic activities** in Laguna Lake (see Operation Stage)

Operation Stage

- Impact on economic activities in Laguna Lake:
  - **fishery** (open lake fishing, fish culture, fish sanctuary),
  - **water intake** for domestic water and irrigation,
  - **water transportation** (ferry navigation, mooring facilities, etc.)

6.4 Considerations necessary for Major Potential Impacts

Potential Impacts	Measures for Mitigation and Compensation
Land acquisition and resettlement	• Just compensation for affected lands and structures based on RA No. 10752 and other relevant laws and regulations. • IEC (information, education and communication) with PAPs and coordination with GAs (Government Agencies) and LGUs for proper resettlement.
Traffic disturbance by project-related traffic	• Development of Traffic Management Plan based on the detailed traffic survey. • The Plan should include: - Consideration in the transportation route and time of construction materials, - Deployment of traffic control person, - Public relation by means of mass media on schedule of construction works, etc.
Generation of excavated materials	• Development of disposal/reclamation site and/or utilization of existing disposal/reclamation site through coordination with relevant GA (including PRA) and LGUs.
Generation of solid wastes	• Treatment and disposal based on RA No. 9003 (*Ecological Solid Waste Management Act*) and RA. 6969 (*Toxic Substances and Hazardous and Nuclear Wastes Control Act*). • Reuse and recycle of the demolished utilizing Material Recovery Facilities (MRFs) through segregation of the wastes.
Impacts on economic activities in Laguna Lake	• Conduct of detailed investigation on existing economic activities in Laguna Lake, • Formulation of impact mitigation measures including: - coordination with local fisher folks, - establishment of alternative and/or temporary facilities for existing inland, water intake, water transportation, navigation, mooring, etc.

6.5 Impact on Manila Bay Environment

Based on the survey thus far, it looks like that the environmental impact of Parañaque Spillway on Mnila Bay is small. There are three reasons.

1. <u>Amount of fresh water</u>
   Pampanga River contributes approximately 50% of all fresh water that enters Manila Bay. Compared to the water from Pampanga River, the increase in flow rate by the Parañaque Spillway is smaller, and the total amount of fresh water doesn't change. Therefore, it is not likely to decrease the density of chloride of Manila Bay.
2. <u>Water Quality</u>
   Owning to the control by LLDA, the water quality of Laguna de Bay is better than that of Manila Bay.
3. <u>Sediment</u>
   Sediment concentration of the water discharged through the spillway is expected to be small because Laguna de Bay works as a settling basin. In addition, the tributaries which are main sediment source enter the central and eastern part of the lake and the intake of the spillway will be constructed in western part of the lake. Considering the low current velocity in the lake, sediment is not likely to transported to the intake.

Republic of the Philippines
Department of Public Works and Highways
Manila

Title/Description: THIRD STEERING COMMITTEE MEETING FOR THE DATA COLLECTION SURVEY ON PARAÑAQUE SPILLWAY IN METRO MANILA
Minutes of Meeting

Date:	Started	Adjourned	Venue
January 23, 2018	1:40 P.M.	4:30 P.M.	Operations Room, 2nd floor, DPWH Central Office, Port Area, Manila
Attendees:		**Topics:**	
Please see attached marked **"ANNEX 1"**		1. Schedule 2. Findings 3. Design Scale and Hydrological/Runoff Inundation Analysis 4. Full Menu of Comprehensive Flood Management Plan for Laguna de Bay Lakeshore Area 5. Comprehensive Flood Management Plan 6. Preliminary Environmental and Social Analysis	

Topic	Session Highlights and Discussion	Person Responsible
	The Meeting was chaired by Undersecretary Emil K. Sadain, CESO I, for UPMO Operations and Technical Services, Department of Public Works and Highways (DPWH). The results of the study were explained by Mr. Takahiro Mishina, Leader of the JICA Survey Team and discussions were made. The highlights of the meeting are summarized below:	
1. Call to Order	• Usec. Sadain called the meeting into order at 1:45 P.M. • Project Manager Leonila R. Mercado of the UPMO – Flood Control Management Cluster (FCMC) acknowledged the presence of the members/representatives of the Steering Committee. • After the acknowledgement, Usec. Sadain requested the JICA Survey Team to present the updates/status of the Survey.	

	• Mr. Mishina presented the results of the survey for the Parañaque Spillway together with the Comprehensive Flood Management Plan.	
2. Findings	• Usec. Sadain noted that the EIRR of Case B, Parañaque Spillway being the priority project for the Comprehensive Flood Management Project is estimated at 8.2 to 10.3%. He asked if in the computation of EIRR, the impact of the dam and retarding basin projects in the Pasig-Marikina River Improvement Project (PMRCIP, Phase 3 and 4) was included already. ➢ Mr. Mishina replied that the two mentioned projects must be considered separately from the Parañaque Spillway Study. He also explained that to increase the EIRR, further study must be undertaken on the particular methodology to be used as there are two (2) methods being considered (Shield Tunneling and NATM Technology). • Usec. Sadain inquired on the possibility of reducing the diameter of the tunnel from 12 meters to 10 meters in order to increase the EIRR. ➢ Mr. Mishina explained that reducing the diameter of the tunnel is not effective as it will also lessen the outflow of flood waters. Instead, he suggested to reduce the return period from 100 year to 50 year. • Usec. Sadain inquired if the CBK hydro power plant utilization of water was considered in the study. ➢ Mr. Mishina responded that it was already considered as the amount of water used by CBK is minimal and has no effect in the study. • In addition, Usec. Sadain informed that the DPWH has an on-going Feasibility Study (FS) and Detailed Engineering Design (DED) on Marikina Dam and proposed Road Network Projects for Laguna de Bay which is scheduled to commence in February 2018, wherein, some common references must be looked into for evaluation/assessment/analysis. There can be some economic impact that might increase the EIRR to make the Parañaque project more feasible. • Usec. Sadain also mentioned about the concern on the budget for Road Right-of-Way (RROW) and relocation of affected Informal Settler	JICA Survey Team

	Families (ISF). He emphasized that there should be more specific and definite numbers of ISF in order to realize the impact on the computed EIRR to increase its viability for approval. • Laguna Lake Development Authority (LLDA) Assistant General Manager Generoso M. Dungo asked if the proposed reclamation area of the LLDA with the Philippine Reclamation Authority (PRA) for a total area of 13,000 hectares has been included in the evaluation of the Study Team. ➢ The Consultant informed that it will visit the LLDA to clarify the information. • Parañaque City Environment and Natural Resources Office (CENRO) asked the particular benefits the LGU will receive from the Parañaque Spillway Project predominantly on their drainage system as they are experiencing flooding. ➢ Mr. Mishina replied that the Parañaque River was considered in the Pre-FS.	
3. Study on Parañaque Spillway	• Usec. Sadain asked how the calculations of Parañaque Spillway project can be adjusted to improve the EIRR of 7.3 -9.1% as the National Economic Development Authority (NEDA) requires an EIRR of 10% to approve any proposed project. • Dr. Glen Q. Tabios of the UP-National Hydraulic Research Center (UP-NHRC) recommended that the "return period" may not be the basis for the approval of the project as mentioned in the 2nd SC meeting. He clarified and stressed to the probability of including the scenario of Marikina Dam in the study using the Agos River towards the Pacific Ocean. ➢ PM Hipolito clarified that the Study is specific for the Parañaque area. However, it depends on the Study team if they have still time to include the scenario. ➢ The Study Team requested Dr. Tabios for the calculations he made for the said situation, and agreed to share his data.	JICA Study Team
4. Study on Combination of Flood Management Measures	• PM Hipolito has three (3) clarifications: o The term "residual area" used in the presentation.	

	➢ Mr. Mishina replied that they will modify the terms used in the sentence to make it clear. o Clarifications if in the modelling, the Study Team used the two (2) software (MIKE11 and RRI), and the viability of the results. ➢ Mr. Mishina explained that the MIKE11 needs the cross section data of the lake wherein no data is available. He said that if there is cross sectional data then RRI model can be used to provide short term scenario results. o The potential impact of a bill or law that requires any effluent or flood water to be treated prior to discharging. As this will have impact on the Operation and Maintenance cost and the design of the spillway. ➢ The Project Team answered that this matter will be studied/considered.	

Review and Confirmation:		
Prepared by:	Approved by:	Noted:
三品孝浩 **TAKAHIRO MISHINA**	5/15 **PATRICK B. GATAN, CESO III**	**EMIL K. SADAIN, CESO I**
Project Team Leader JICA Survey Team	Project Director UPMO – FCMC	Undersecretary for UPMO Operations and Technical Services
Position	Position	Position

ANNEX 1 ATTENDANCE SHEET

Date:	Started:	Adjourned:	Venue:
January 23,2018	1:30 PM	4:30 PM	2nd Floor Operations Room, Office of the Secretary, DPWH Head Office, Bonifacio Drive, Port Area Manila

ATTENDANCE SHEET

Name	Office	Contact Number	Signature
1. Usec. Emil K. Sadain	DPWH-UPMO Operations		
2.Glen Q. Tabios	UP- National Hydraulic Research Center		
3.Michael Auguilar	LGU-Las Piñas		
4.Shellowin de Leon	LGU-Parañaque		
5.Ma. Teresa R. Quigue	LGU-Parañaque		
6.Justin de Ramos	DENR- NCR		
7.Renz Mario Gamido	DENR - NCR		
8.Dethermina Basillio	DILG-NCR		
9.George T. Gomez	MMDA		
10.Jonathan T. Gomez	MMDA		
11.Emiterio C. Hernandez	LLDA		
12. Generoso M. Dungo	LLDA		
13.Ruel S. Casimiro	DPWH-IV-A		
14.Leonardo Lingan	DPWH - BOD		
15.E.C Matangihan	DPWH- BOD		
16.Ricchelieu Felipe I. Lim	DPWH- BOD		
17.Constante A. Llanes Jr.	DPWH – Planning Service		
18.Leonila R. Mercado	DPWH – UPMO-FCMC		
19.Michael Alpasan	DPWH – UPMO-FCMC		
20.Mark Zaplan	DPWH – UPMO-FCMC		

ATTENDANCE SHEET

Name	Office	Contact Number	Signature
21.Dolores M. Hipolito	DPWH – UPMO-FCMC		
22.Jesse C. Felizardo	DPWH-UPMO - FCMC		
23.Ayume Oshima	JICA -PP		
24.Kimiko Hayashi	JICA -PP		
25.Cathy Palanca	JICA PP		
26.Junji Miwa	JICA Expert		
27.Takafumi Nakui	JICA Expert		
28.Satoshi Takata	JICA Survey Team		
29.Takahiro Mishina	JICA Survey Team		
30.Geraldine Santos	JICA Survey Team		
31.Riza S. Nanas	JICA Survey Team		
32.Eleazar Rupido	JICA Survey Team		
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