添付資料　1

添付資料 1-4　4th　Steering Committee

Data Collection Survey on Parañaque Spillway in Metro Manila

4th Steering Committee Meeting

April 4, 2018

Japan International Cooperation Agency

CTI Engineering International Co., Ltd. (CTII)
Nippon Koei Co., Ltd. (NK)
CTI Engineering Co., Ltd. (CTIE)

Schedule

- July 31,2017 : Started the Survey in the Philippines
- August 10-11,2017 : Site Investigation
- August 17,2017 : First Steering Committee
- November 03,2017 : Second Steering Committee
- January 23, 2018 : Third Steering Committee
- End of January, 2018 : Submission of Interim Report
- April 4, 2018 : Fourth Steering Committee
- Middle of April, 2018 : Submission of Draft Final Report
- Middle of May, 2018 : Submission of Final Report

Work Items \ Period	2017						2018					
	7	8	9	10	11	12	1	2	3	4	5	6
【A】Domestic Preparation Works and Consultation of IC/R with JICA												
【B】Comprehensive Flood Management Plan of Laguna de Bay Lakeshores Area												
【C】Pre-Feasibility Study of Paranaque Spillway												
Report		IC/R					IT/R		DF/R		F/R	

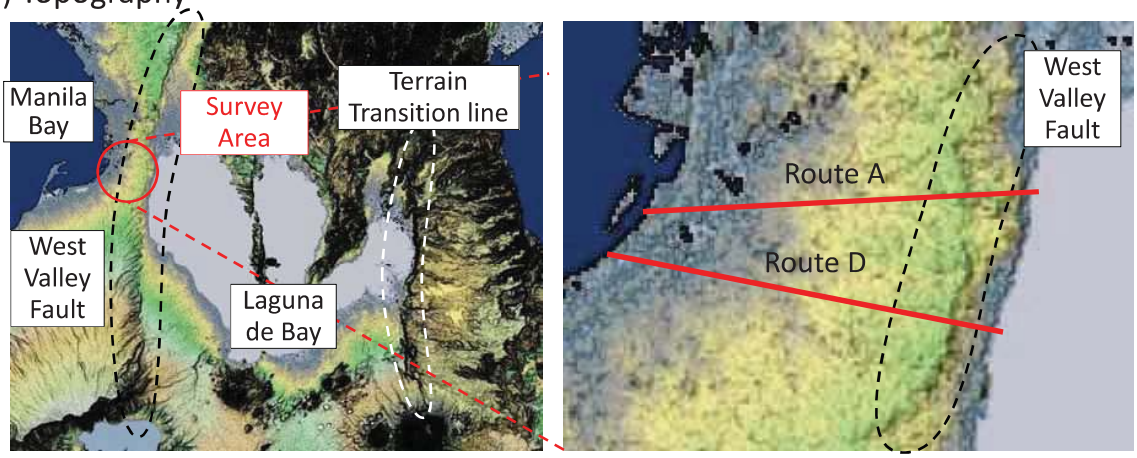
Source: JICA Survey Team

Topic (Results of Feasibility Study)

1. Topographical and Geological Condition
2. Basic Design of Parañaque Spillway
3. Construction Plan
4. Procurement Plan
5. Non-structural Measures
6. Operation and Maintenance
7. Environmental Issues
8. Water Quality
9. Implementation Plan
10. Preliminary Cost Estimate
11. Economic Evaluation and Verification of the Project
12. Study on Downstream River Channel

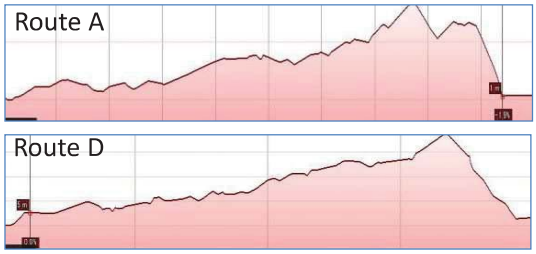
1. Topographical and Geological Condition

1) Topography



Source: SRTM, Visualized by JICA Survey Team

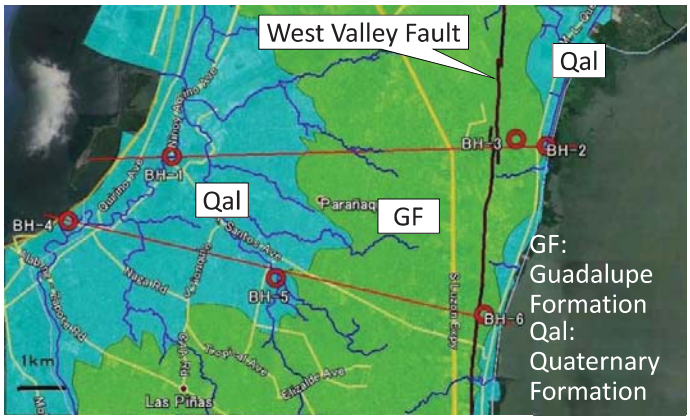
- The West Valley Fault in the Valley Fault System can be seen in north-south direction, west side of Laguna de Bay.
- The elevation becomes gradually higher toward Laguna de Bay. After the peak of hilly land at around 40m, the elevation drops at lakeshore area of Laguna de Bay.



Source: Google Earth, Visualized by JICA Survey Team

1. Topographical and Geological Condition

2) Geology



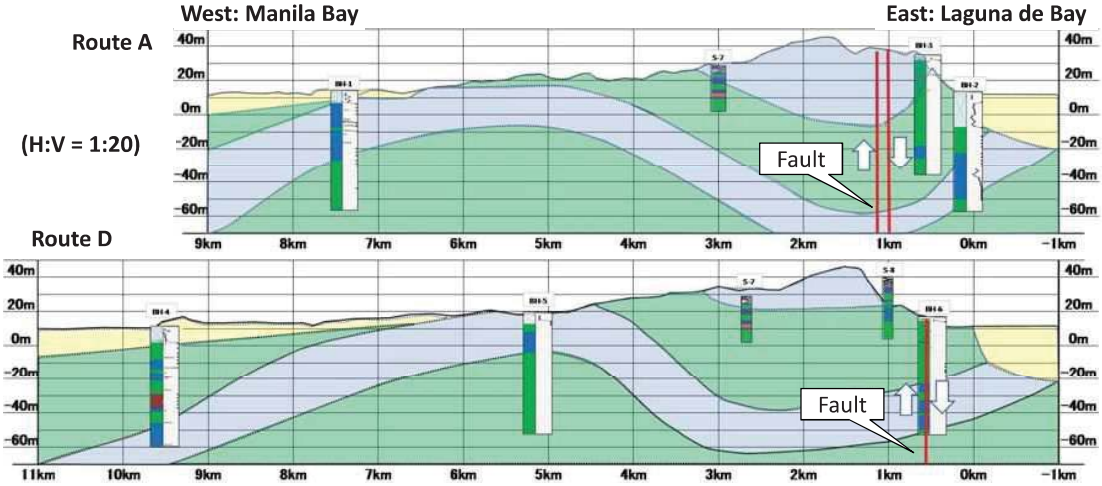
Source: Geology of the Philippines, MGB, revised by JICA Survey Team

Source: JICA Survey Team

- <u>Basement rock in this hilly land:</u>
  Pleistocene Guadalupe Formation (GF), mainly composed of volcanic clastic rocks (tuff, lapilli tuff, tuff gravel rock, volcanic ash silt etc.,) so-called “soft rocks.”
- <u>Lowlands on the western side of the hill and the lakeshore area of Laguna de Bay:</u>
  Holocene Quaternary Alluvium (Qal), unconsolidated deposits such as clay, silt, sand, and gravel covers the basement soft rocks.

1. Topographical and Geological Condition

3) Geology (Longitudinal Section and Soil Parameters)



Source: JICA Survey Team

- There are few cracks in the rocks, and the permeability is considered to be small.
- Uniaxial compressive strength of the basement rock is 24.2 Mpa on average.
- N values: Alluvium: approx.10 to 30, basement rocks excluding surface weathered: more than 50.

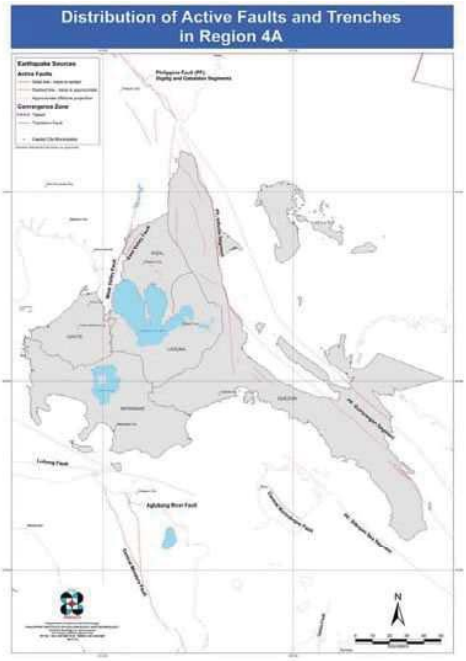
Alluvium Unconsolidated clay and silt, unconsolidated sand and gravel etc.

Massive Tuff Rock Lapilli tuff, sandy tuff, pumice tuff etc.

Layered Tuff Rock Fine tuff, volcanic ash silt, clay etc.

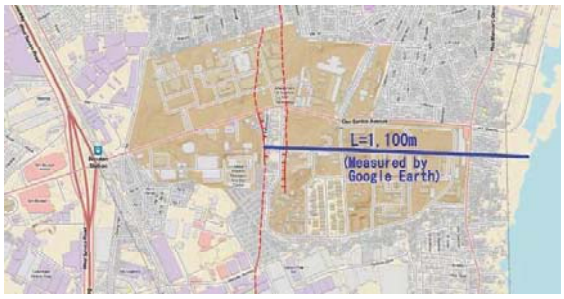
2. Basic Design of Parañaque Spillway

1) Countermeasure for West Valley Fault



Location Map of Geological Faults in Region-4A

Source: http://202.90.128.67/html/update_GGRDD/Maps/AF-and-Trenches/Regional/Luzon/Region%204A.png



Geological Fault Map of Lower Bicutan

Source: http://faultfinder.phivolcs.dost.gov.ph/

Geological Fault Map of Sucat

Source: http://faultfinder.phivolcs.dost.gov.ph/

2. Basic Design of Parañaque Spillway

1) Countermeasure for West Valley Fault

Table 7.2.1 Comparison of Countermeasures for Tunnel at West Valley Fault

Measure	Flexible Structure	Reinforced Lining	Repair after Movement	Open Channel
Summary	Flexible Structure is adapted at the fault against the deformation by the movement.	For soft ground, the lining shall be designed strongly enough to resist the deformation.	Basically, after the movement, the tunnel damages shall be repaired.	Open channel is adapted from Laguna de Bay to the fault because of easy to be fixed.
Problem	It may be difficult to adjust the deformation if the movement will be concentrated several meters.	It is very difficult for the stiff soil, because the load caused by the movement will be huge.	If move, it will be necessary to restore others. Therefore, obtaining the budget is difficult.	Land acquisition and resettlement are necessary between Laguna de Bay and Intake Facility.
Others	-	-	Expensive of O. & M. Cost	Easy for O. & M.
Cost	Generally expensive	Generally expensive	Initial cost is cheap but repair cost is expensive	Expensive for land acquisition and resettlement cost
Evaluation	Not impossible but the safety is not guaranteed.	Not impossible but the safety is not guaranteed.	Budget for repair will be a problem.	The most practical measure
	Δ	Δ	Δ	O: Selected

Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

2) Influence on Subway and Railway Projects

Table 7.2.2 Influence on Subway and Railway Projects

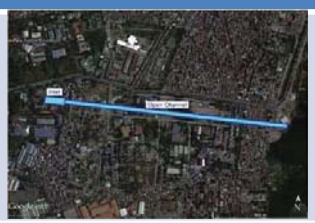
Type	Project Name	Summary	Influence of Spillway	Remarks
Railway	LTR-1 Cavite Extension	▪This line will pass from center of Manila through Parañaque City to Las Piñas City. ▪The line goes through the west side of San Dionisio River and crossing Zapote River.	▪No influence around Parañaque River ▪Outlet of the spillway is near the railroad line at Zapote River	▪Basically, no problem ▪Negotiation & measures will be necessary if Zapote River is used.
Subway	Mega Manila Subway Project (JICA)	This line will pass from center of Manila through Parañaque City to Las Piñas City.	No influence with the 50m-depth spillway plan	▪No problem ▪No clear progress after JICA's Data Collection Survey in 2015.
Railway	North-South Railway Project South Line	Existing line will be renovated to the doubled lines and/or viaduct bridge.	▪The inlet open channel crosses the railroad line at the ground level in Sucat. ▪The channel crosses a viaduct bridge in Lower Bicutan.	▪Basically, no problem ▪Negotiation & measures will be necessary if Sucat area is used.

Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

3) Location of Intake Facility

Table 7.2.3 Comparison of Intake Facility Location of Parañaque Spillway

Place	Lower Bicutan	Sucat
Location		
Spillway Length	Parañaque River System Lp=6.0km Zapote River Lz=9.1km	Parañaque River System Lp=6.8km Zapote River Lz=8.8km
Site Condition	It is necessary to relocate large-scale facilities, such as Polytechnic University of Philippines.	Mainly un-used ground is wildly spaced but adjacent to church.
Social Environment	1200m of the Open Channel is longer than Sucat and the land acquisition area is also wider.	600m of the Open Channel is shorter than Lower Bicutan and then fewer resettlements is advantage.
Cost	Basically more economical	More expansive due to longer tunnel
Evaluation	Even if wider land acquisition and many resettlements, more economical.	Advantage of social environment, especially the land acquisition.
	O: More economical	O: Easy Land Acquisition

Legend: ◎;Excellent、○;Good、△;Not Good/Some Problem、×;Difficult/ Impossible

Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

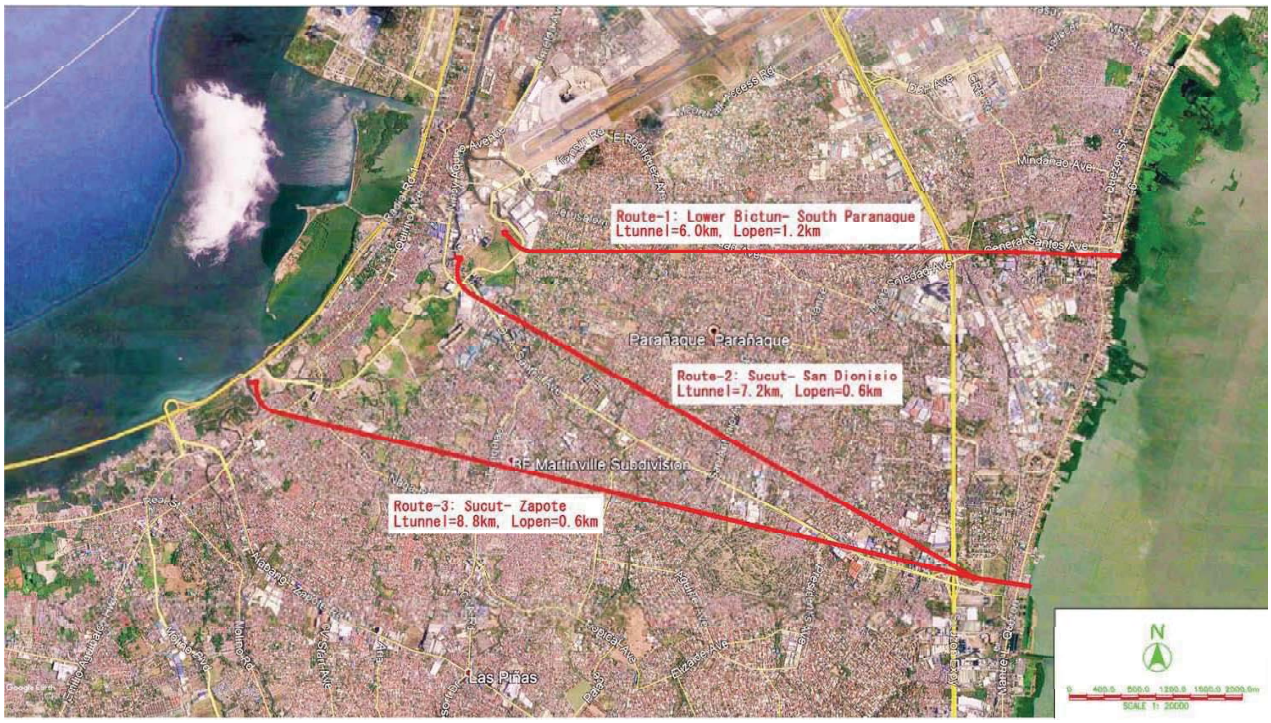
4) Location of Drainage Facility

Table 7.2.4 Comparison of Drainage Facility Location of Parañaque Spillway

River	South Parañaque River	San Dionisio River	Zapote River
Location			
Spillway Length	South Parañaque- Lower Bicutan Spillway Lp=6.0km Open Channel Lo=1.2km South Parañaque- Sucat Spillway Lp=6.8km Open Channel Lo=0.6km	San Dionisio- Lower Bicutan Spillway Lp=6.6km Open Channel Lo=1.2km San Dionisio- Sucat Spillway Lp=7.2km Open Channel Lo=0.6km	Zapote River- Lower Bicutan Spillway Lp=9.1km Open Channel Lo=1.2km Zapote River- Sucat Spillway Lp=8.8km Open Channel Lo=0.6km
Site	There is sufficient open space area.	There is adequate open space area.	There is substantial open space area at the right.
River Improve-ment	The channel width around the drainage facility is not enough.	The confluence with South Parañaque River and its upstream are narrow.	There are a few problems because of the wide river and near the river mouth.
LPPCHEA	Relatively large influence than Zapote River Case.	Relatively large influence than Zapote River Case.	Relatively small influence than Parañaque River Case.
Cost	The cheapest plan	The intermediate plan	The most expensive plan
Eval.	O: High Possibility	O: Possible	O: Promising

2. Basic Design of Parañaque Spillway

5) Alignment Plan of Spillway



Alignment Plan of Parañaque Spillway

Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

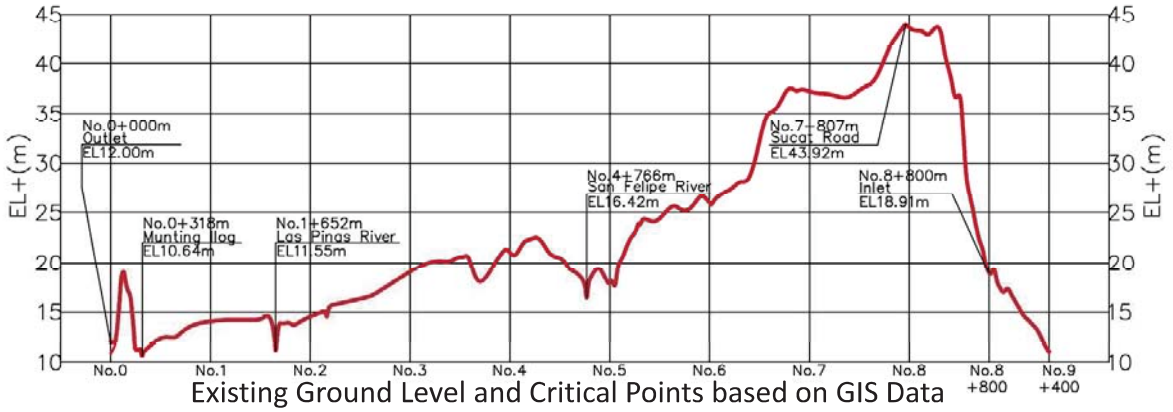
5) Alignment Plan of Spillway

Table 7.2.5 Comparison of Alignment Plan of Parañaque Spillway

Route	Route-1: Lower Bicutan to South Parañaque River	Route-2: Sucat to San Dionisio River	Route-3: Sucat to Zapote River
Summary	Basically straight line between Lower Bicutan and South Parañaque River	Basically straight line between Sucat and San Dionisio River	Basically straight line between Sucat and Zapote River
Spillway Length	South Parañaque- Low. Bicutan Spillway Lp=6.0km Open Channel Lo=1.2km	San Dionisio- Sucat Spillway Lp=7.2km Open Channel Lo=0.6km	Zapote River- Sucat Spillway Lp=8.8km Open Channel Lo=0.6km
Site	It is necessary to relocate large-scale facilities. such as Polytechnic University	Mainly un-used ground is wildly spaced but adjacent to church.	
River Improve-ment	Widely required river improvement area due to the narrow channel.	Required river improv. area is up & down streams of drainage facility.	Required river improv. area is smallest among 3 rivers.
Social Environ-ment	The length of 1200m of the Open Channel is longer than Sucat.	It is necessary to make the resettlement of Laguna de Bay lakeshore area.	
LPPCHEA	Relatively large influence than Zapote River Case.	Relatively small influence than Parañaque River Case.	
Cost	The cheapest plan	The intermediate plan	The most expensive plan
Eval.	O: Possible	Δ	O: Promising

2. Basic Design of Parañaque Spillway

6) Longitudinal Plan (Route-3)



Existing Ground Level and Critical Points based on GIS Data

Table 7.2.7 Longitudinal Plan of Shield Tunneling Method

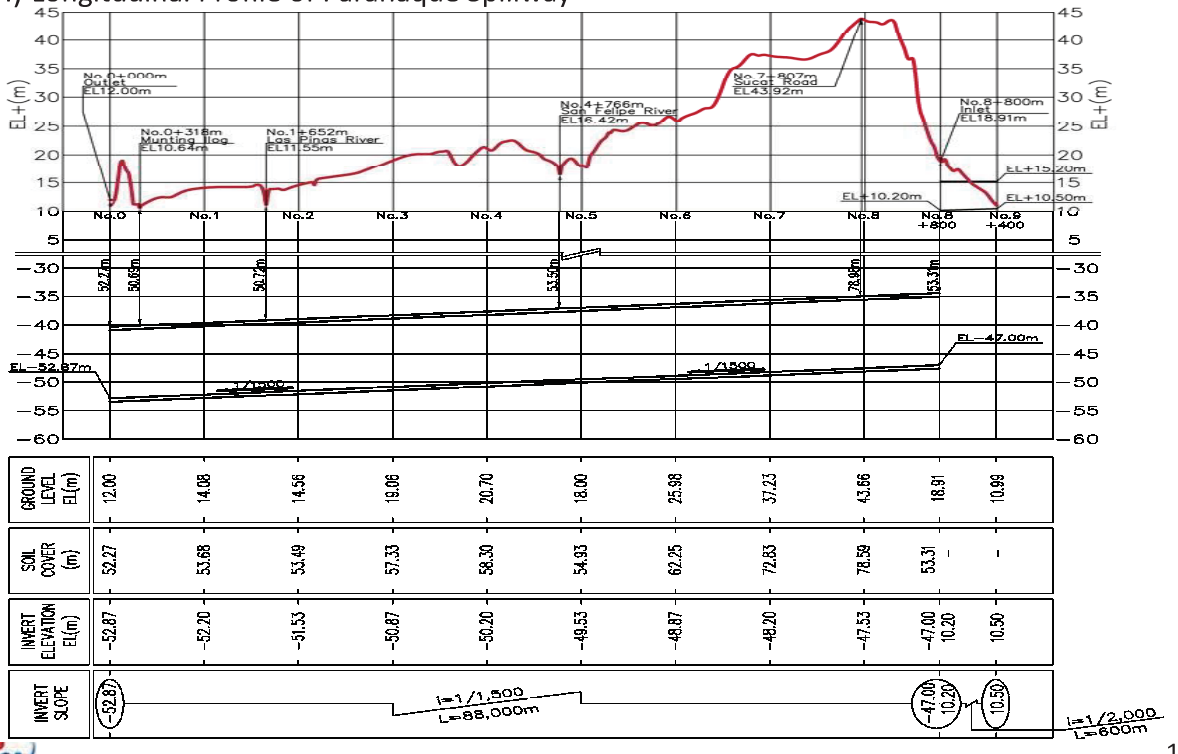
Station	Cumul. Dis. (m)	Place	Ground Level EL(m)	Invert Elevation EL(m)	Slope	Soil Cover (m)	Note
No.0+000	0m	Outlet Shaft	+12.00	-52.87	1/1,500	52.27	Complemented
No.0+318	318m	Munting Ilog	+10.64	-52.65		50.69	Critical Point
No.1+652	1,652m	Las Piñas River	+11.55	-51.77		50.72	
No.4+766	4,766m	San Felipe River	+16.42	-49.68		53.50	
No.7+807	7,807m	The highest Point	+43.92	-47.66		78.98	
No.8+800	8,800m	Inlet Shaft	+18.91	-47.00		53.31	
		Down. of Open Channel		+10.20	1/2,000	—	Open Channel
No.9+400	9,400m	Upst. of Open Channel	+10.99	+10.50		—	Section

Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

7) Outline Drawing (Route-3)

i) Longitudinal Profile of Parañaque Spillway

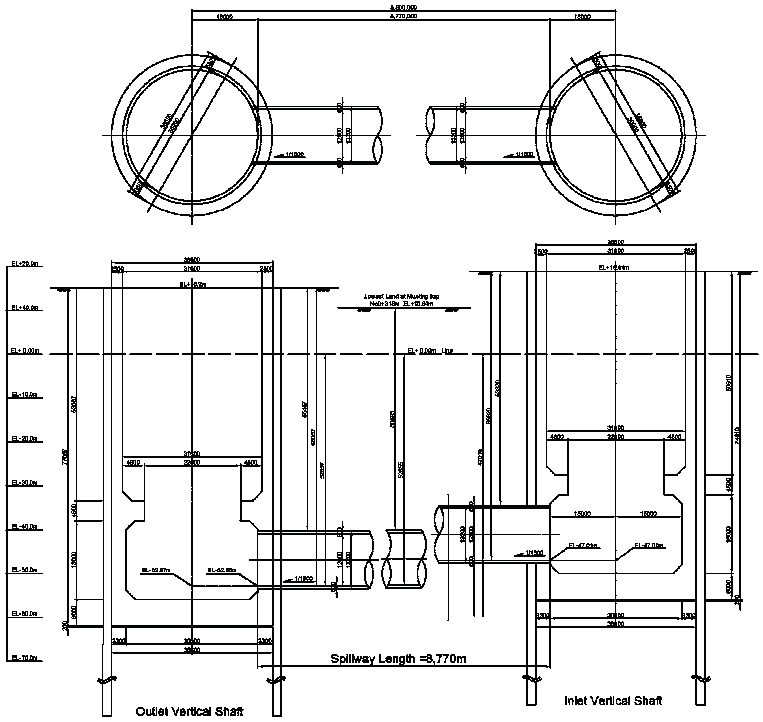


Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

7) Outline Drawing (Route-3)

ii) Plan Drawing of Vertical Shaft of Inlet and Outlet

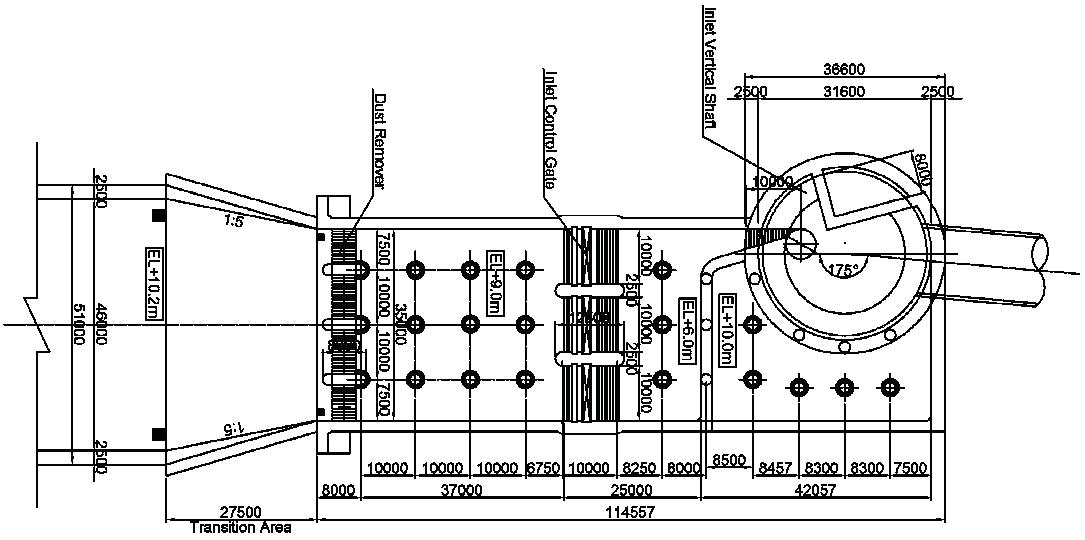


Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

7) Outline Drawing (Route-3)

iii) Plan Drawing of Intake Facility

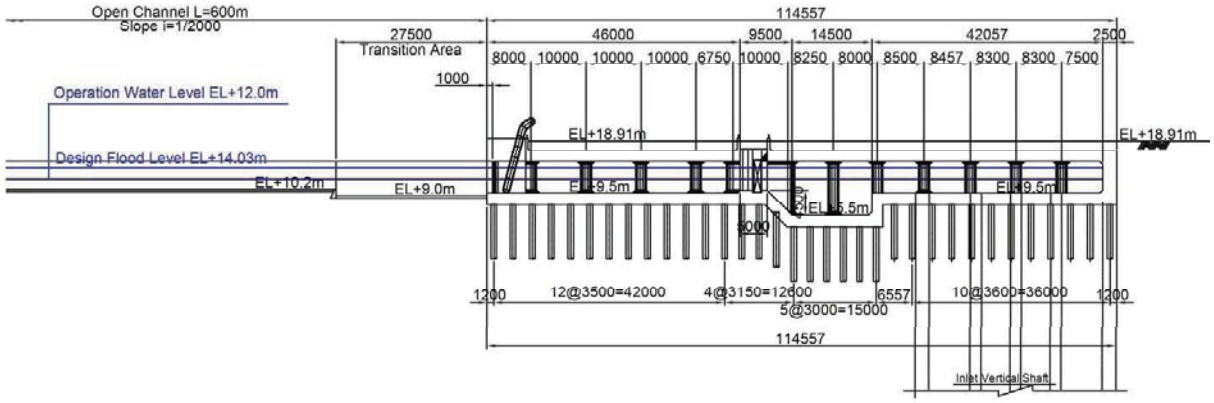


Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

7) Outline Drawing (Route-3)

iv) Cross Section Drawing of Intake Facility

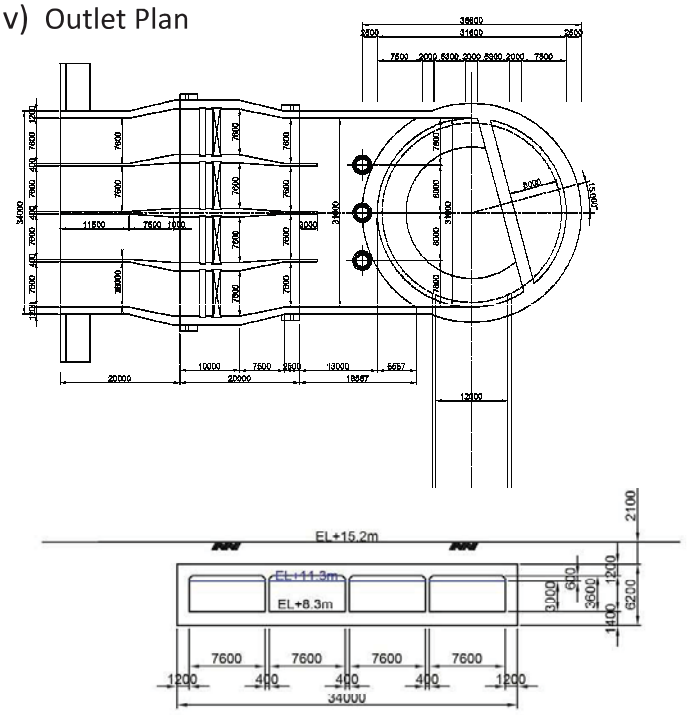


Source: JICA Survey Team

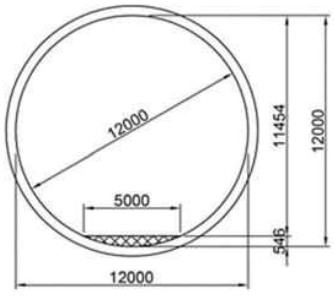
2. Basic Design of Parañaque Spill

7) Outline Drawing (Route-3)

v) Outlet Plan



Vi) Tunnel Cross Section



Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

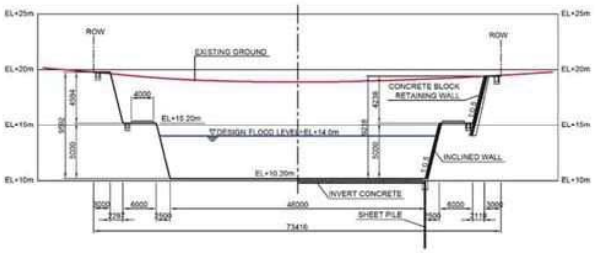
7) Outline Drawing (Route-3)

vii) Standard Cross Section of Intake Open Channel

SECTION NO.0

SECTION NO.3

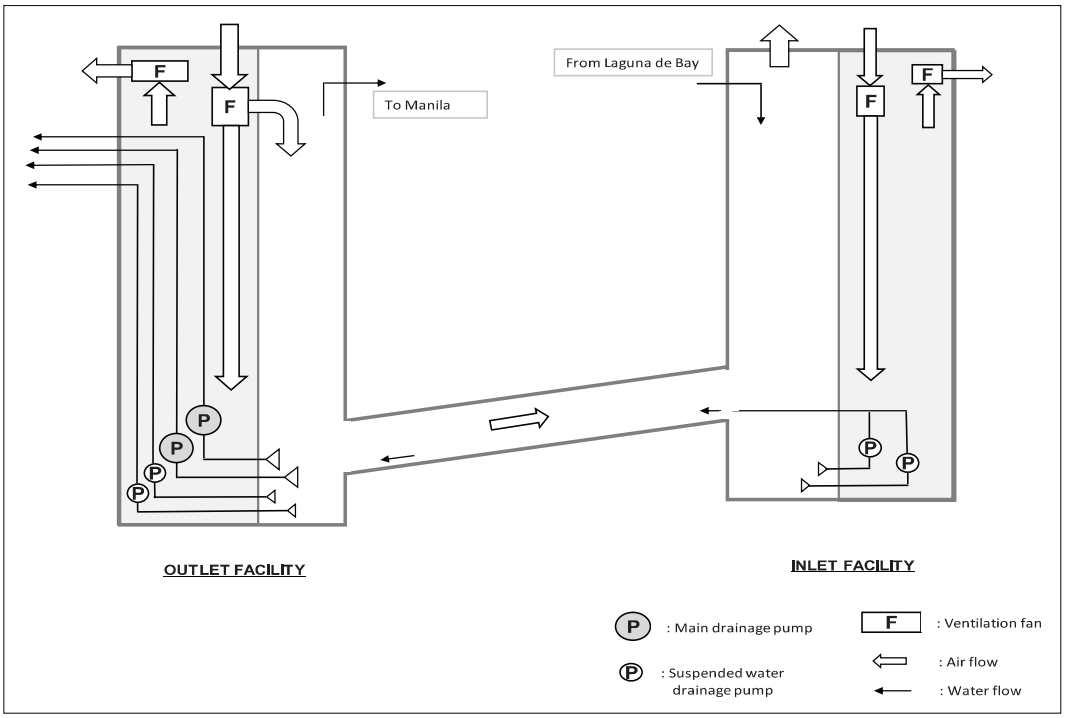
SECTION NO.6



Source: JICA Survey Team

2. Basic Design of Parañaque Spillway

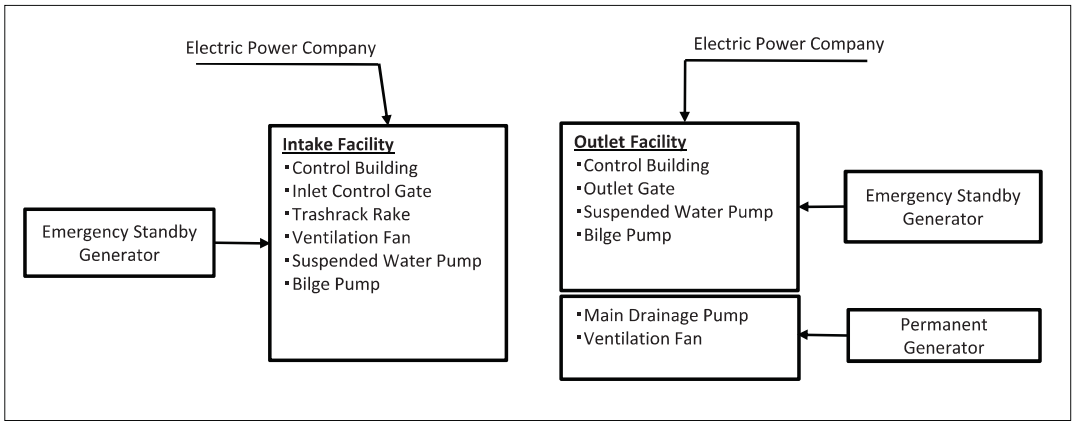
Design of Pump and Gate



Drainage and Ventilation System Diagram

2. Basic Design of Parañaque Spillway

Design of Pump and Gate



Electric Power Supply System

Outlet Facility

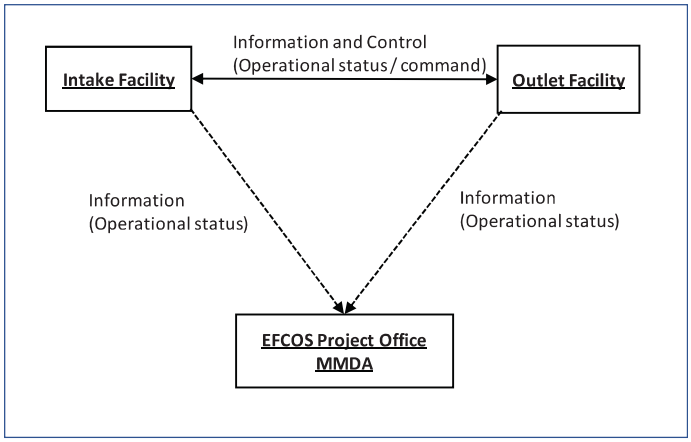
Main drainage pump : 1.4m^3/sec x 1,300kW x 2 units Drainage period of 5 days

Ventilation fan : 2,200m^3/min Required amount of ventilation for the tunnel

These two equipment are supplied electricity by permanent generator (in-house power generator).

2. Basic Design of Parañaque Spillway

Design of Pump and Gate



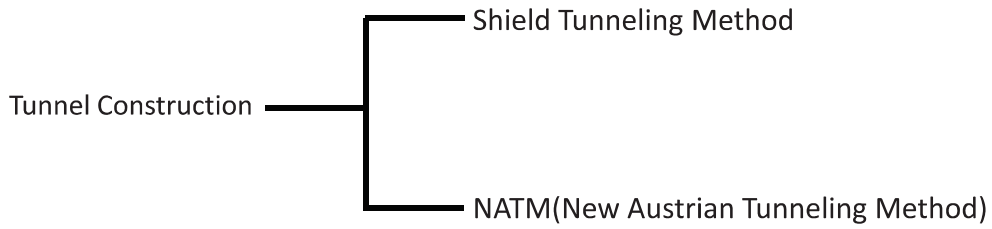
Supervisory Control System

Information and Control
(Between both Facilities)
- Water level
- Operational Status
- Remote Control of Equipment
- Video Monitoring

(Inflow / Discharge, Operation of Equipment, Security in the premises)

Information to EFCOS Project Office
- Water level
- Operational status of the equipment
  (Source on/off, Pump run/stop, Gate open/close, etc.)

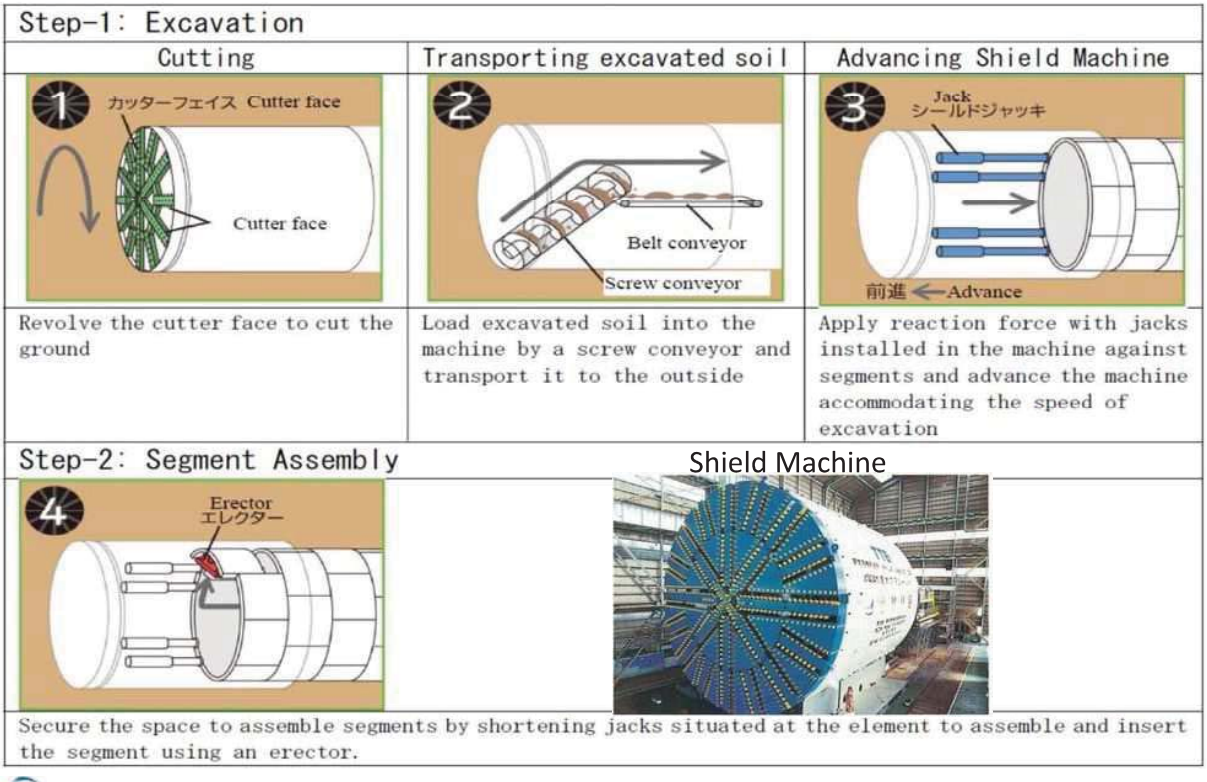
3. Construction Plan
a. Tunnel Construction



Shield Tunneling Method : Excavate with the shield machine by stabilizing the face against earth pressure and water pressure using mud pressure or muddy water pressure and assemble segments to retain the ground

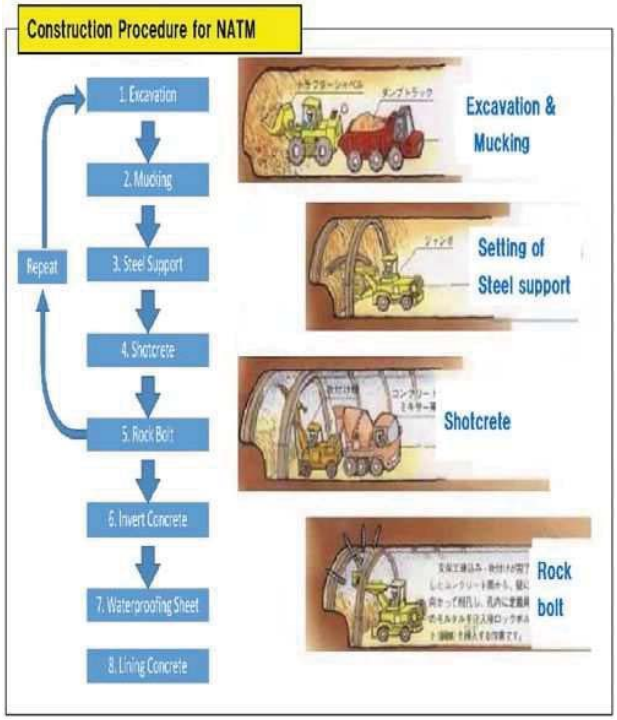
NATM : Excavate by stabilizing the ground using shotcrete, rockbolts and steel support etc. utilizing the support function of surrounding ground

3. Construction Plan
b. Shield Tunneling Method (Construction Procedure)

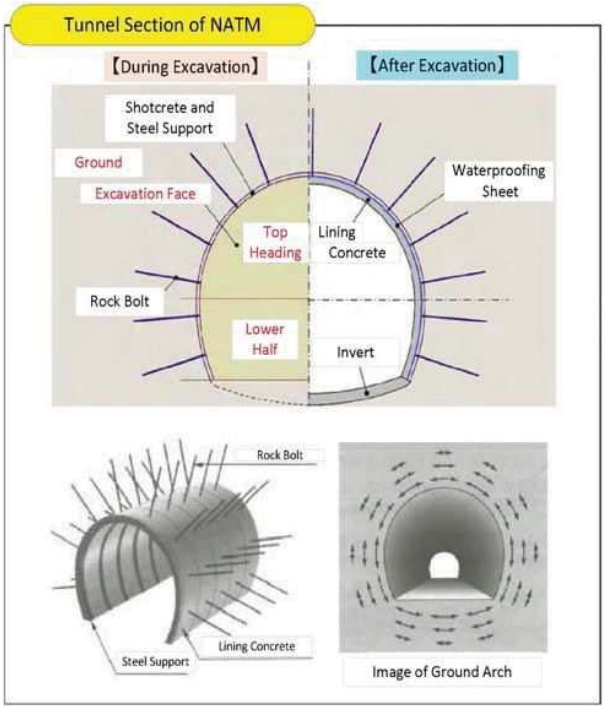


Source: North Line HP from Metropolitan Expressway Company Limited

3. Construction Plan
c. NATM (Construction Procedure and Cross Section)



Source: Design Practice to Understand the Concept Well 7 from Tunnel Designing



Source: Design Practice to Understand the Concept Well 7 from Tunnel Designing

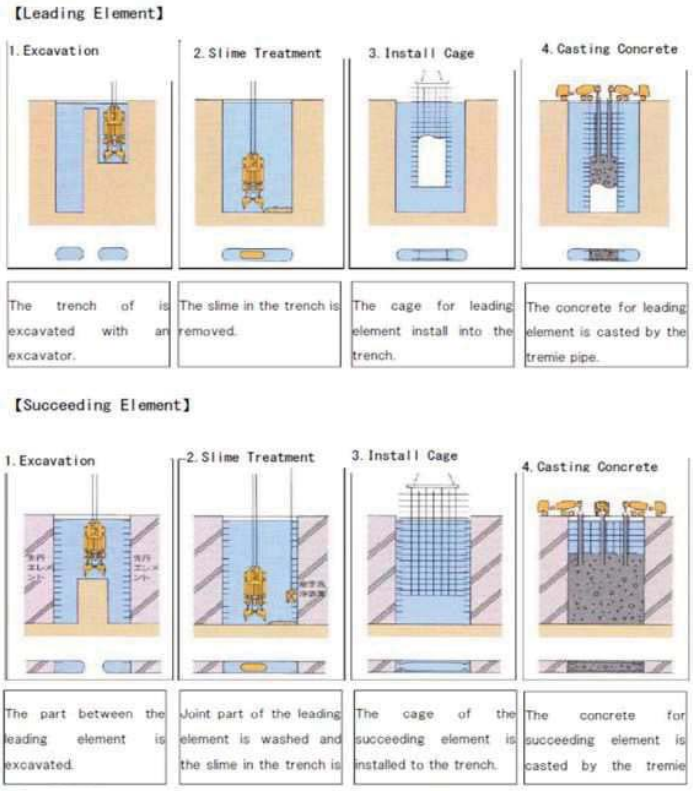
3. Construction Plan
d. Shafts Construction

- Shafts Construction
  - RC Diaphragm Wall Method
  - Open-Caisson Method

RC Diaphragm Wall Method : Inserting reinforcement cages into drilling grooves excavated using slurry and replacing slurry with concrete to cast continuous RC wall

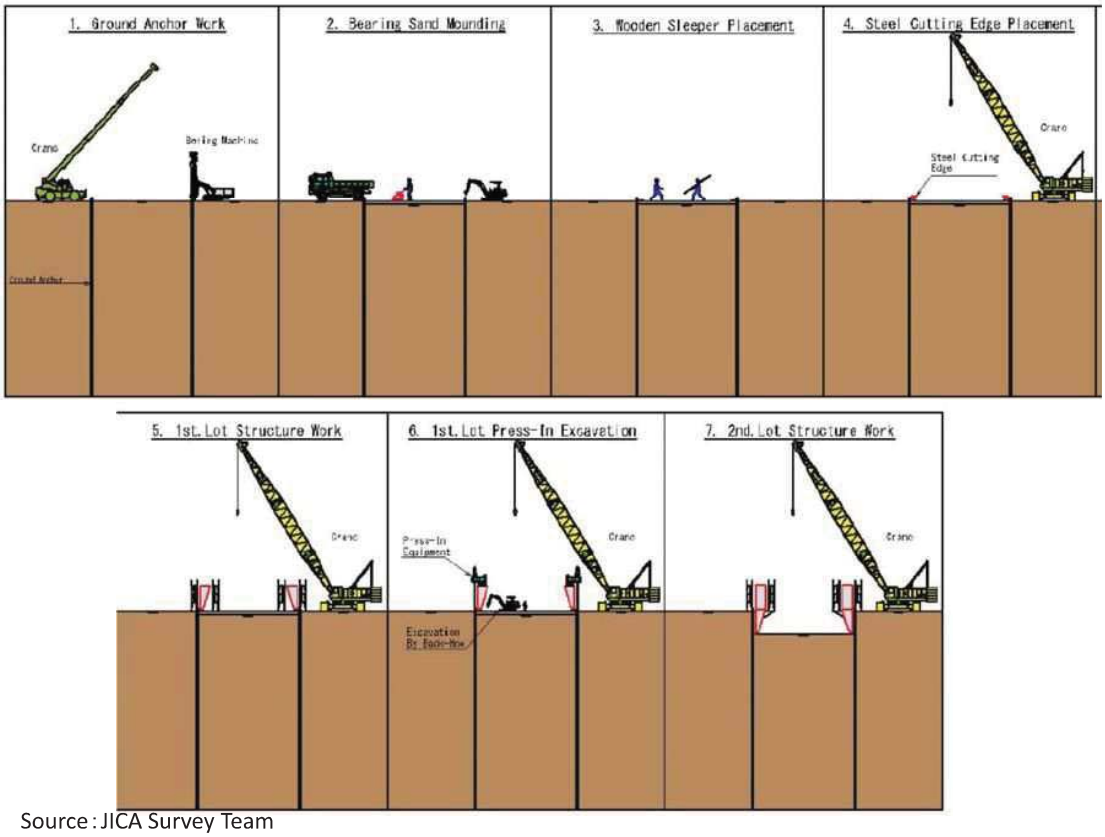
Open-Caisson Method : The main frame of caisson to be installed into the ground by using reaction force of dead weight and ground anchors

3. Construction Plan
e. RC Diaphragm Wall Method (Construction Procedure)



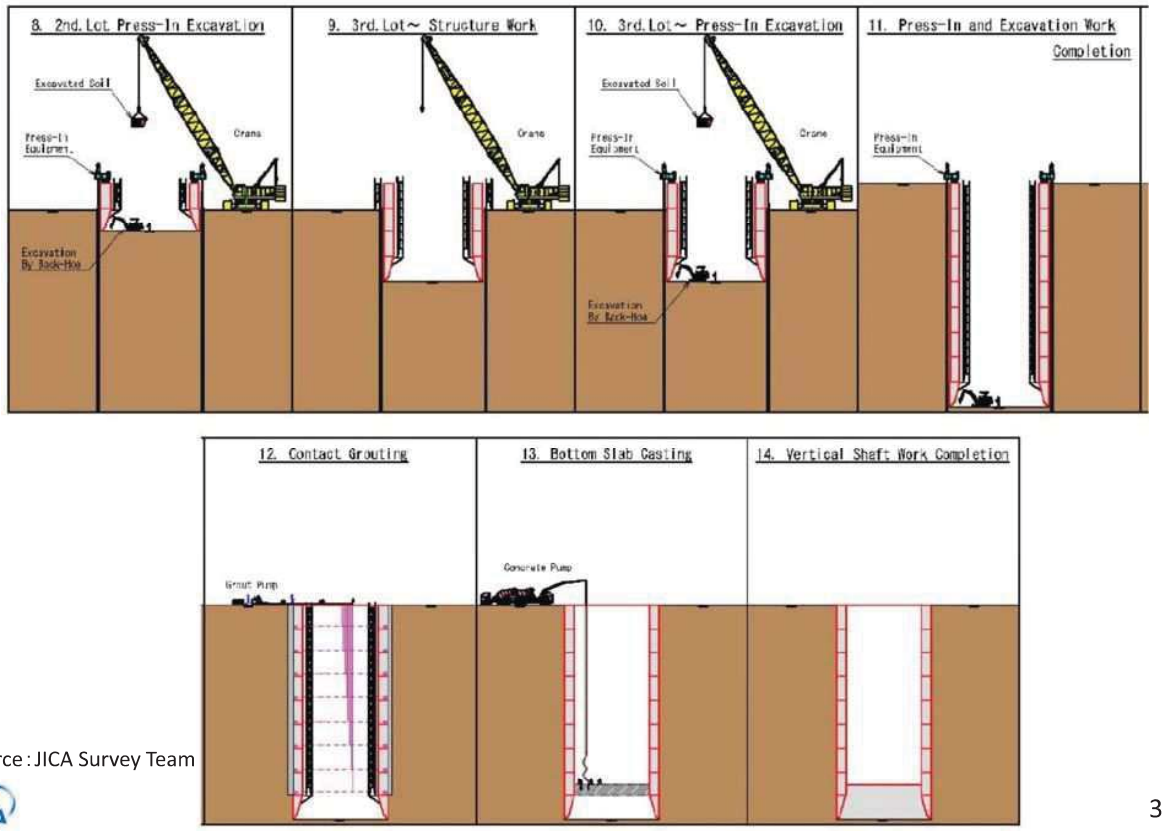
Source: Source: Diaphragm Wall Association (http://www7b.biglobe.ne.jp/~renpeki/index.html)

3. Construction Plan
f. Open –Caisson Method (Construction Procedure-1)



Source : JICA Survey Team

3. Construction Plan
f. Open –Caisson Method (Construction Procedure 2)



Source : JICA Survey Team

3. Construction Plan
g. Surplus Soil Disposal

- **Surplus Soil Volume**

	Route and Method	Soil Volume (m3)
Option1	Route-1 , Shield	1,700,000
Option2	Route-1, NATM	1,800,000
Option3	Route-3, Shield	1,650,000
Option4	Route-3, NATM	1,750,000

- **Disposal Site** : Designated Disposal Site in Laguna Lake to be secured (within 10km from the launching Shaft)

- Another Option: Re-use of surplus soil ; **permanent reclamation land** in Laguna Lake (estimated construction cost=about 2,300 million PHP Area:45ha, Height: 4m, Volume: 1,800,000m^3

4. Procurement Plan
a. Items to be procured from Foreign Countries - Tunnel

Works	Items		Remarks
Tunnel Works (Shield Tunneling Methods)	Material	Backfilling Material	
		Additive (Mud Additive)	
	Equipment	Shield Machine	Japan, Western Countries (Germany, America, etc.)
		Plant	Japan, Western Countries, Singapore, Taiwan, China, etc.
		Segment Lifter	Unloading of Segments into Shafts
	Labor	Technical Staff	Overall Tunneling Works
		Maintenance Staff	Repair and Maintenance of the above Machineries
Tunnel Works (NATM)	Material	Support Materials (Rock Bolt, Steel Support)	
	Temporary Material	Movable Formwork for Lining Concrete	
	Equipment	Drill Jumbo	Hydraulic Drifter (Making Narrow Holes by Rock Bolt)
		Shotcrete Machine	
		Brower	
		Measurement Apparatus	
	Labor	Technical Staff	Overall Tunneling Works
		Maintenance Staff	Repair and Maintenance on the above Machineries

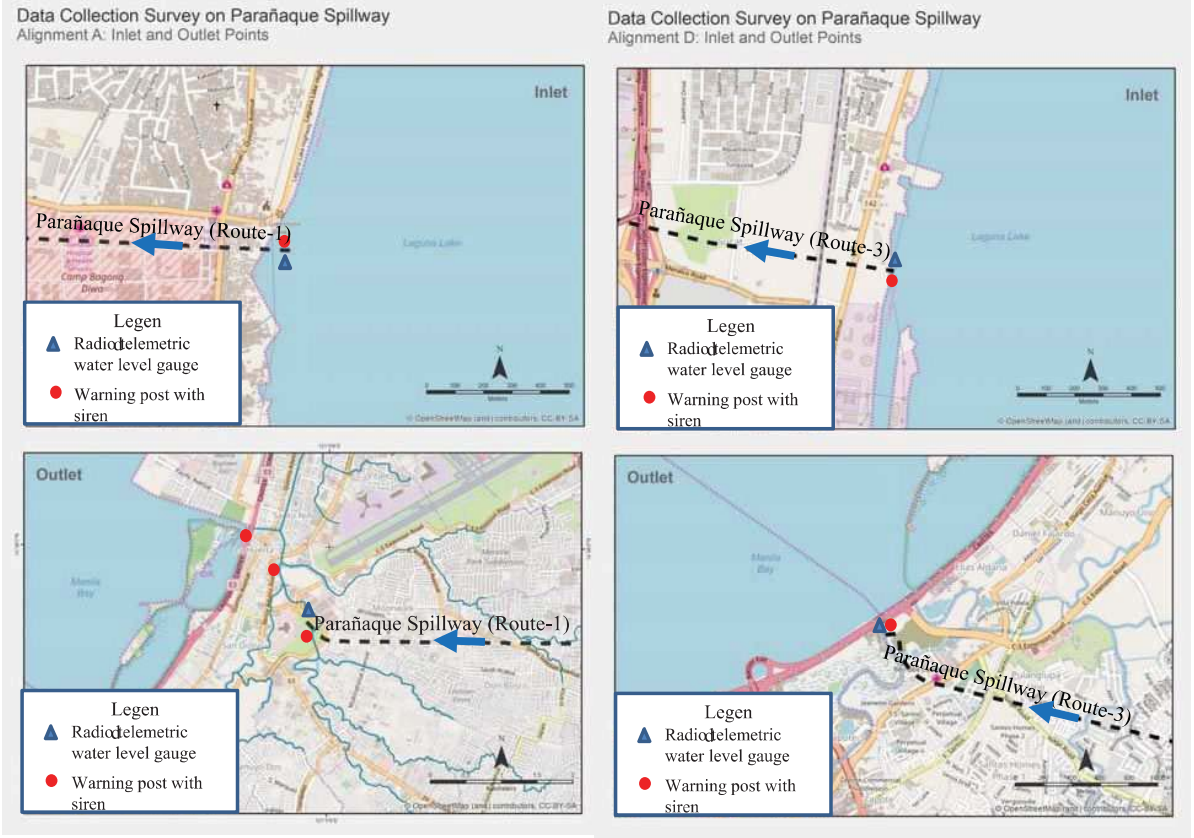
【Remarks】 Segments for Shield : Local Fabrication to be considered subject to the guidance from foreign supplier

4. Procurement Plan
b. Items to be procured from Foreign Countries – Shafts, M&E

Works	Items		Remarks
Construction of Shafts (Open Caisson Method)	Equipment	Jacking Apparatus ・Boring Machine ・Anchor for Reaction Force ・Press-in Jacks ・Press-in Beams ・Reinforcing Steel Plate of Cutting Edge	Procurement from Japan (the team for the construction of shafts)
	Labor	Technical Advisor	
Construction of Shafts (Diaphragm Wall)	Equipment	Trencher	Japan, Western Countries, Singapore, etc.
		Muddy Water Treatment Plant	Ditto
	Labor	Technical Advisor	Ditto
M&E	Equipment	Pump, Ventilation Fan, Screening Equipment, Gate, Control Panel, etc.	Ditto

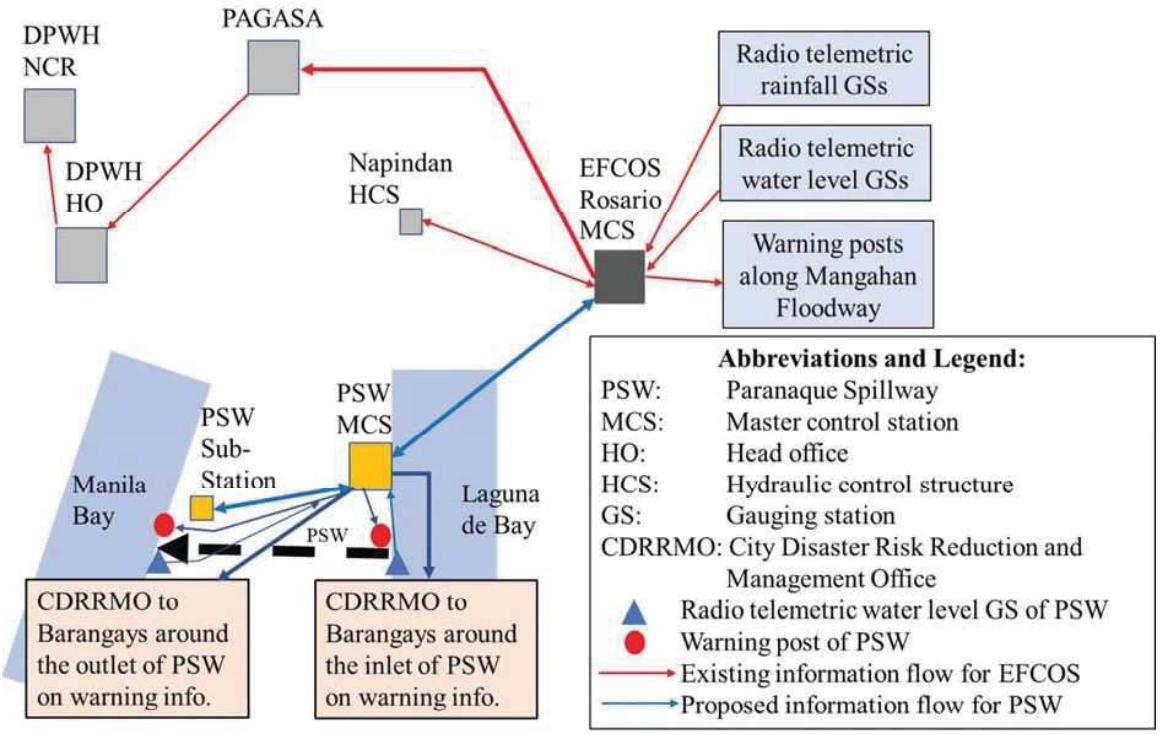
5. Non-structural Measures

Radio Telemetric Water Level Gauges and Warning Posts with Siren for Operation of the PSW



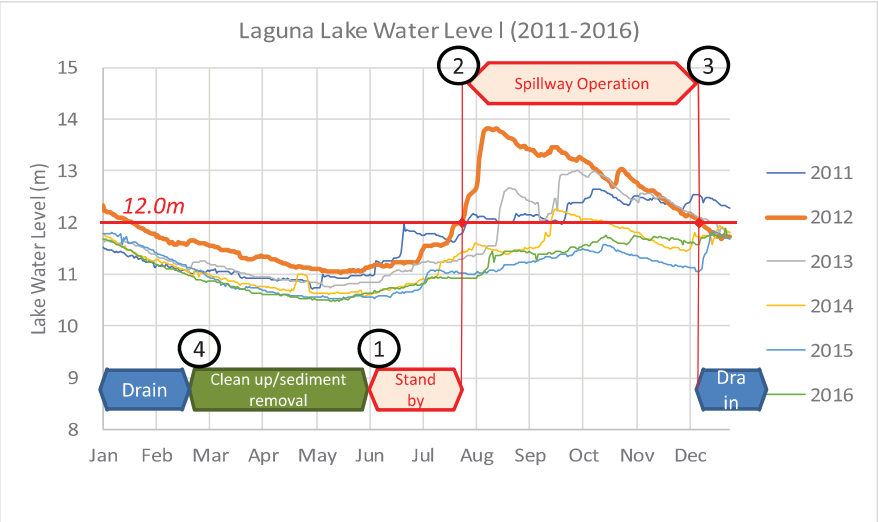
5. Non-structural Measures

Radio Telemetric Water Level Gauges and Warning Posts with Siren for Operation of the PSW



6. Operation and Maintenance

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

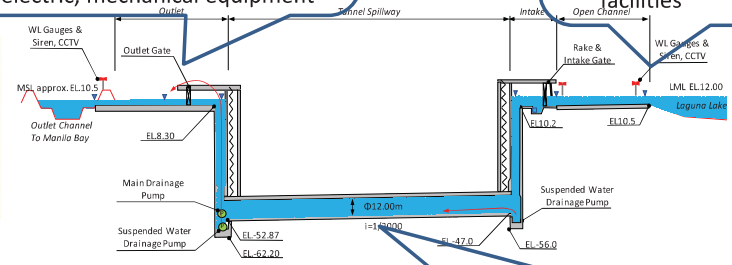
Items of Works for O&M on the Parañaque Spillway

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)	

6. Operation and Maintenance

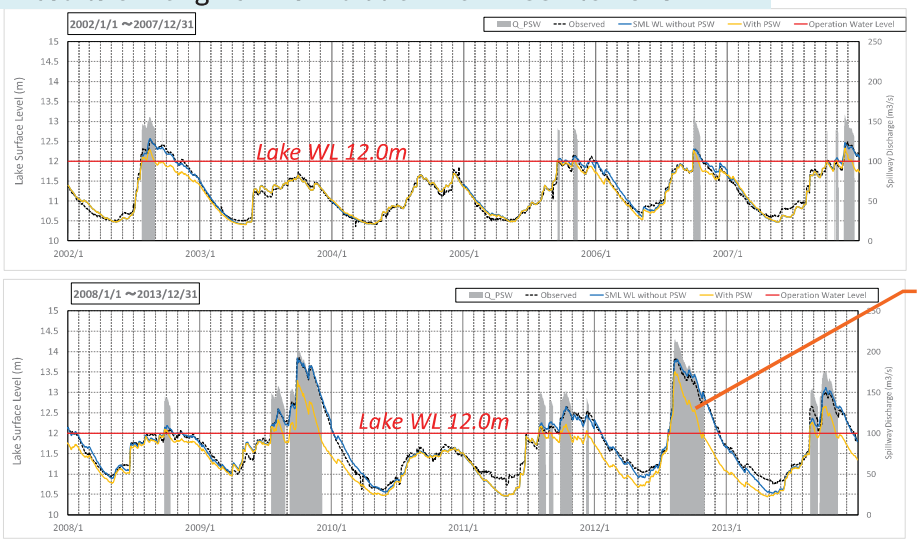
Proposal for Organization
for Comprehensive Flood Control Works in Laguna de Bay

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 construction area of 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.
- ✓ 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. Operation and Maintenance

Results of Long-Term Simulation from 2002 to 2013



Basic Information of the Parañaque Spillway Operation

year	Operation Period	The Number of Operation Date (days)	Operation Frequency (times)	Total Spillway Discharge (million m^3)
Min.	July-December	0	0	0
Max.		129	4	1,785
Average		42.3	1.7	556

6. Operation and Maintenance

Operation and Maintenance Cost for The Priority Project (Parañaque Spillway)

Item	Items	O&M Cost (million PHP)	
		Route-1	Route-3
Parañaque Spillway	Operation cost of drainage pump	1.3	1.6
	Maintenance cost of hydromechanical facilities,	17.9	17.9
	Maintenance cost of underground tunnels	142.9	201.8
	Sediment removal and cleaning of spillway tunnel	13.6	16.6
	Sub-Total	**175.7**	**237.9**
Expansion of EFCOS	O&M of Electrical and Mechanical Equipment	1.1	1.1

6. Operation and Maintenance

Issues and Considerations on Operation, Maintenance and Management

< Operational Issues and Considerations >

① Establishment of organization system of operation, maintenance and management
② Securing budgetary allocation
③ Securing human resources
④ Coordination and Cooperation with LLDA and LGUs

<Technical Issues and Considerations>

① Establishment of methodology and procedure and operation and maintenance
② Countermeasures for garbage and sedimentations
③ Establishment of monitoring and measurements system
④ Social and environmental consideration on operation, maintenance and management
⑤ Study for cost reduction of operation, maintenance and management