REPUBLIC OF THE PHILIPPINES
METRO MANILA DEVELOPMENT AUTHORITY (MMDA)

REPUBLIC OF THE PHILIPPINES

ADVISORY SERVICES FOR FLOOD MANAGEMENT ON PROJECT FOR IMPROVEMENT/RESTORATION OF TELEMETRY EQUIPMENT OF EFFECTIVE FLOOD CONTROL OPERATION SYSTEM (EFCOS)

SERVICES COMPLETION REPORT

MARCH 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CTI ENGINEERING INTERNATIONAL CO., LTD.

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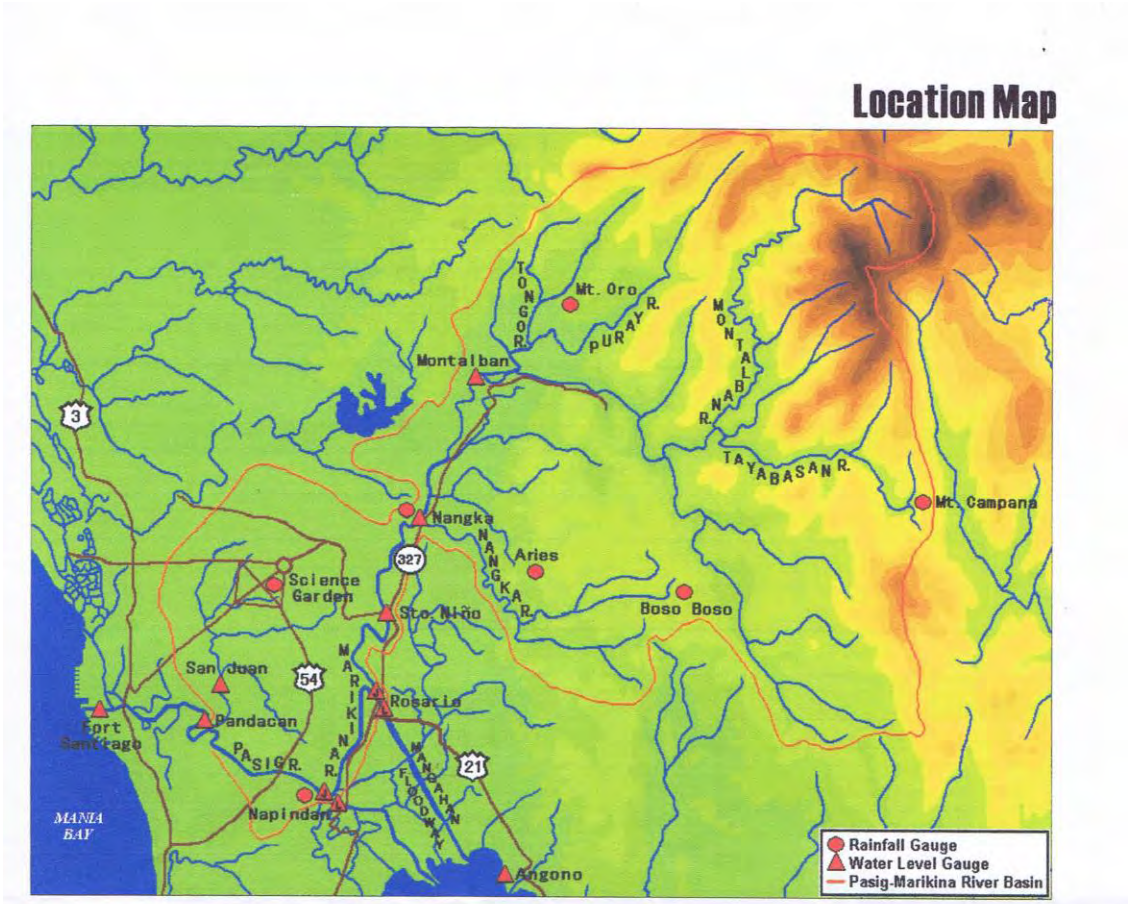

Rosario Weir and Upper Rosario Master Control Station

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1. BACKGROUND AND OBJECTIVE OF SERVICES

1.1 Background

The Republic of the Philippines is one of the most serious disaster-prone countries in the world. Damage caused by recurrent natural disasters extends widely, affecting its socio-economic and human resources. Among the natural disasters, the typhoons, tropical storms and floods account for most of the damage, thus countermeasures and responses against such disasters are the most essential and critical in the disaster risk management sector in the Philippines.

Metro Manila is the center of politics, economy and culture of the Philippines. Due to its natural topography of coastal low-lying areas, the area is naturally prone to typhoons; therefore frequent flooding has caused adverse effects on the regional socio-economic aspect in Metro Manila, as well as to the national socio-economic aspect.

In this context, the Government of Japan (GOJ) has been continuously providing technical support on flood control measures in Metro Manila since the 1970s, particularly projects in the Pasig-Marikina River Basin. The major projects include the *Pasig River Flood Control Project*, the *Effective Flood Control Operation System (EFCOS)* (under the Nationwide Flood Control and Dredging Project (Telemetering)), and the on-going *Pasig-Marikina River Channel Improvement Project*. Since the completion in 1993, EFCOS has long been an important component of flood control system in Metro Manila functioning as a flood forecasting and early warning system for the area. For its significance, rehabilitation and improvement works of EFCOS was implemented in 2001 under the *Project for Rehabilitation of the Flood Control Operation and Warning System in Metro Manila*, a Grant Aid project of GOJ.

However, due to repeated onslaught of large-scale typhoons/tropical storms, such as *Milenyo* in September 2006 and *Ondoy* in September 2009, in and nearby Metro Manila the EFCOS facilities including monitoring equipment and telecommunication system were heavily damaged resulting to malfunction of the system as a whole. Responding to the severe damages of those typhoons, the Government of the Philippines (GOP), through the Metropolitan Manila Development Authority (MMDA), has been exerting its efforts to repair EFCOS using its own budget. However, complete rehabilitation with its own budget has been very difficult since the damaged equipment/system includes major and expensive parts which also requires technical examination for rehabilitation.

In recent years, floods brought about by typhoons and monsoonal storms occur more frequently than before in Metro Manila; therefore rehabilitation of the EFCOS has become an urgent and critical issue. With this situation, the GOP requested GOJ for assistance to "Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS)" (hereinafter referred to as the "Project") with the aim to restore the function of EFCOS by rehabilitating the damaged facilities/equipment.

In response to the request, JICA dispatched a survey mission to the Philippines in July 2014 for the purpose of developing a detailed plan for the Project. During their stay in the Philippines, the JICA Mission carried out the field inspections of existing overall system. Then, Mission exchanged views and held a series of discussions on damaged facilities/equipment to be repaired/replaced, frequency changes, works to be done by MMDA, etc., with the representatives of relevant organizations.

Results of discussions were concluded as Memorandum of Understanding (MOU) between JICA and MMDA which signed in October 2014.

In addition, draft detailed planning for the Project was compiled in the report of Detailed Planning Survey (October 2014). In this report, it is pointed out that the number of EFCOS's human resources and budget for proper operation and maintenance are currently in shortage.

1.2 Objective of Services

The objective of services by the JICA short-term Expert is to provide technical advices on planning of Operation and Maintenance (O&M) including staff training and budget allocation plans, etc., for MMDA for the sustainability of newly rehabilitated/improved EFCOS, which will aim to increase the development effect.

2. SCOPE OF SERVICES AND ACTUAL SCHEDULE

Services consisted of three phases: Services in Japan for preparation, Services in the Philippines and Services in Japan for preparation of report.

(1) Services in Japan (5 days: January 4 to January 8, 2016)

1) Understanding project and background including review of existing related reports
2) Preparation of draft Work Plan
3) To obtain information on work progress of the improvement/restoration work implementation

(2) Services in the Philippines (46 days: January 10 to February 24, 2016)

The Services in the Philippines have been conducted at the EFCOS Project Office in Rosario, Pasig City. The scope of Services in the Philippines is as follows:

1) Discussions with the agencies concerned and survey of implementing organization
2) Monitoring of work progress of the telemetry works and civil works
3) Confirmation of the current status and project plan of MMDA and other donors including functional roles of EFCOS from the overall perspective of greater Metro Manila flood control management
4) Reconfirmation on scope of Services of JICA Expert
5) Confirmation on responsibilities of MMDA and its actions to be taken
6) Study on recommendations in terms of Project implementation and O&M for EFCOS during/after the rehabilitation works
7) Advices, comments and recommendations to MMDA on O&M
8) Seminar/Workshop on O&M
9) Preparation of Activity Accomplishment Report
10) Others as required

(3) Services in Japan (5 days: March 7 to March 11, 2016)

1) Preparation of Services Completion Report

Actual time schedule for the Services is shown below:

Actual Time Schedule of the Services

Services Item	January 2016			February 2016			March 2016		
	10	20	31	10	20	29	10	20	31
1. Services in Japan for Preparation (5 days)	4	8							
2. Services in the Philippines (46 days)	10						24		
(1) Monitor of work progress of the Project									
(2) Confirmation on responsibilities of MMDA for the EFCOS Project implementation									
(3) Discussions with the agencies concerned									
(4) Confirmation of current status of MMDA and other agencies and donors concerned, including flood control plan of greater Metro Manila									
(5) Review and reconfirmation on scope of Services									
(6) Advices, comments and recommendations to MMDA on O&M including preparation of draft O&M Plan									
(7) Seminar on O&M						18			
(8) Preparation of Activity Accomplishment Report						24			
3. Services in Japan (5 days)									
(1) Preparation of Services Completion Report							7	11	
【Reporting】	①				*	②		③	

Note: ①Work Plan, * Draft O/M Plan, ②Activity Accomplishment Report, and ③Services Completion Report

3. MONITORING OF PROGRESS OF IMPROVEMENT/RESTORATION WORKS

All civil works carried out by MMDA were completed by January. Procurement and installation works of equipment was contracted on June 11, 2015 and completed actually by February 6, 2016. The following are summary of improvement/restoration works. Planed/actual implementation schedule is attached herewith.

Progress of works are summarized as follows. (Implementation schedule of the improvement/restoration project is presented in Section 11)

(1) Civil Works

Based on the MOU between MMDA and JICA signed in October 2015, MMDA implemented the following civil works:

1) Construction of 2nd floor of Nangka Station (completed in July 2015)
2) Construction of 2nd floor of Warning Post No.8 (completed in August 2015)
3) Renovation of EFCOS equipment room at Napindan HCS Building (Air-conditioning) (completed in December 2015)
4) Renovation of Antipolo Relay Station (Air-conditioning) (completed in December 2015)
5) Construction of tower at Napindan HCS (completed in January 2016)

Nangka Observation Station damaged by flood caused by Typhoon Ondoy (photo by EFCOS Office)
(September 2009)

Elevated Nangka Station (January 2016)

Newly constructed Tower at Napindan HCS (Feb. 2016)

(2) Telemetry Equipment Works

1) Contractor: Japan Radio Co., Ltd. (procured by direct appointment method)
2) Contract date: June 11, 2015
3) Original contract time: January 20, 2016 (224 days)
4) Revised contract time: February 26, 2016
5) Contract amount: JPY129,125,592.
6) Works consisting of the following;
   a) Site inspection and design
   b) Kick-off meeting on August 14, 2015
   c) Preparation of approval drawings
   d) Manufacturing
   e) Factory acceptance
   f) Packing and shipment (arrival at EFCOS Office on December 4, 2015)
   g) Procurement of equipment/materials in the Philippines
   h) Installation work
   i) Test and commissioning
   j) Inventory (February 9 to 12, 2016)
   k) Staff training (February 19, March 1 and 2, 2016)

Display of data transmitted on completion of improvement/restoration works

4. RECONFIRMATION OF SERVICES AND MMDA'S RESPONSIBILITIES AND PERFORMANCE

A coordination for the on-going improvement/restoration project meeting among the MMDA, JICA Philippines Office and contractor was held on January 11, 2016 at the MMDA General Manager's meeting room. In the meeting, progress of on-going project and progress of MMDA's responsibilities were discussed and confirmed. Also, kick-off meeting for the Services was included in this meeting and work plan including scope of Services were presented and accepted.

MMDA's responsibilities and its performance were monitored. All requirements have been performed by MMDA.

(1) Timely implementation of civil works such as repairing of stations, construction relay station tower, etc.
(2) Customs and duties, etc. for imported equipment and materials
(3) Transportation of imported equipment/materials within the Philippines
(4) Acquirement of NTC Permit on frequency
(5) Assignment of EFCOS Project counterpart staff
(6) Provision of office, storage room, etc., for project implementation

5. DISCUSSION WITH THE AGENCIES CONCERNED AND SURVEY ON ITS ORGANIZATION

With regard to relationship with the EFCOS Project, discussions and survey of the agencies' implementing structure was conducted. Survey includes ongoing projects, plans, institutional arrangement, issues, etc.

(1) PAGASA - Hydrometeorology Division

Date: January 26 (11:00 to 12:00)
Discussed items:

- ✧ It is informed that EFCOS improvement/restoration works will be completed by February 20.
- ✧ Confirmed are the transmitted data of EFCOS Project on the monitor screen of PAGASA.
- ✧ Monitor screen of KOICA2 Project is not well-functioned for inclusion of EFCOS data.
- ✧ There is confusion on the flood forecasting work implemented by both EFCOS and PAGASA.
- ✧ Hearing of information and data of PAGASA on KOICA2 Project, KOICA3 Project, Project NOAH, Resilience Project, GMMA Project.

(2) OCD-NDRRMC

Date: February 9, 2016 (11:00 to 11:30)
Discussed items:

- ✧ It is informed that EFCOS improvement/restoration works will be completed by February 20.
- ✧ Confirmed are the transmitted data of EFCOS Project on the monitor screen of NDRRMC Operation Center.
- ✧ Schedule of Seminar and training for operation are informed to OCD-NDRRMC.

6. CONFIRMATION OF CURRENT STATUS OF FLOOD CONTROL AND FLOOD FORECASTING AND WARNING SYSTEM IN GREATER METRO MANILA

The necessary data/information in relation to EFCOS can almost obtain from the JICA Study Report on Data Collection Survey on Situation of nationwide Flood Forecasting and Warning System in the Philippines (Sept. 2013). However, data/information are updated as required.

6.1 MMDA

MMDA has the following major present projects and future plans.

(1) Rehabilitation of Existing Large -sized Drainage Pumping Stations and Construction New Drainage Pumping Stations under the World Bank's Assistance

Since the drainage pumping stations constructed in Metro Manila managed by MMDA already deteriorated and their capacities are less than design, MMDA implements an integrated set of interventions to modernize about existing 40 pumping stations and make improvements to appurtenant infrastructure; switch pumps from diesel to electric power where needed; construct new large pumping stations to accommodate urban expansion; increase short-term water retention capacity in the drainage areas. Project name is the Metro Manila Flood Management – Phase 1 (US$362.6 million). The proposed project would be a first phase of support by the Bank for the implementation of the Master Plan and focus on measures to reduce flood risks in the Greater Metro Manila Area.

(2) study on possibility for flood forecasting and warning system along the Tullahan River originating La Mesa Dam. This 15km long river flows in Quezon City, Malabon and Valenzuela. This is the similar plan as KOICA3 of PAGASA

(3) Study on possibility for flood forecasting and warning system in Laguna Lake

6.2 Agencies Concerned and Other Donors

In the flood control of Pasig-Marikina River basin, national government agencies such as DPWH, MMDA,

PAGASA, DOST-ASTI, etc., and international donors (KOICA, CIDA and UNDP) are involved. In particular, the following projects are surveyed in relation to EFCOS.

(1) EWS 2 Project and EWS 3 Project of PAGASA
(2) CIDA/UNDP's Resilience Project
(3) DOST-ASTI's NOAH Project

(1) EWS 2 Project and EWS 3 Project of PAGASA

EWS 2 Project assisted by KOICA has established telemetry rainfall and water level gauging stations in the Pasig-Marikina River basin, including flood forecasting and early warning system.

1) Name of Project: Automation of Flood Early Warning System for Disaster Mitigation in Greater Metro Manila
2) Project Period: Started in November 2010 and completed in May 2012
3) Project Objectives: Establishment of flood forecasting and early warning system in the Pasig-Marikina River Basin
4) Monitoring and Warning Stations installed: 10 rainfall gauging stations, 10 water level station, 30 warning posts and 4 automatic weather stations
5) Management Agency: PAGASA
6) Donor: KOICA

EWS 3 Project started in 2016 and targets the completion in 2017. In the Pasig-Marikina River Basin, the Project will install additional 11 rainfall gauging stations. EWS 3 Project also targets the Tullahan River Basin adjacent to the Pasig-Marikina River Basin by constructing telemetry 4 rainfall gauging stations, 3 water level gauging stations and 14 warning posts. It is proposed to integrate the flood forecasting system of Tulluhan River into the system of the Pasig-Marikina River Basin.

(2) Resilience Project

Objective the Project is to strengthen LGU capacities in disaster risk reduction and management towards building community resilience to disasters and reducing vulnerability to natural hazards. The target area of the Project is Metro Manila. The following is a summary of the Project:

1) Name of Project: Building Community Resilience and Strengthening Local Government Capacities for Recovery and Disaster Risk Management
2) Project Period: Started in 2010 and completed in 2013
3) Project Objectives: To establish a flood early warning system in the Pasig-Marikina River Basin and Tullahan River Basins; to integrate EFCOS, KOICA, NOAH, and the system installed by the Project; and to support strategic roles of LGUs (Marikina-Pasig-Cainta) in creating disaster risk management sensitive policies and plans ensuring people's participation, accountability and partnership with various stakeholders
4) Monitoring and Warning Stations installed: 22 rainfall gauging stations and 1 water level station.
5) Management Agency: OCD-NDRRMC
6) Donor: CIDA (Canadian International Development Agency) 及び UNDP (United Nations Development Plan)

(3) Project NOAH

The Project NOAH（Nationwide Operational Assessment of Hazards) is the DOST's response to the call of the President for a more accurate, integrated, and responsive disaster prevention and mitigation system, especially in high-risk areas throughout the Philippines. The Project is harnessing technologies and management services by the DOST through PAGASA, PHIVOLCS, and the DOST-Advanced Science and Technology Institute (ASTI), in partnership with the UP National Institute of Geological Sciences and the UP College of Engineering.

Originally, the Project NOAH has eight (8) components. Among them, the following three (3) components are closely related to the EFCOS, but these are nationwide target projects. Others have different targets of natural disasters, such as landslides, coastal hazards and storm surge, and different devises development, such as Doppler radar and landslide sensor. These projects progressed targeting the date of December 2013, and the projects enter the operational stages at present.

1) Distribution of hydro-meteorological devices in hard-hit areas in the Philippines (Hydromet): a total of 600 automated rain gauges and 400 water level monitoring stations were installed along the 18 major river basins by December 2013 to provide a better picture of the country's surface water in relation to flooding.
2) Disaster risk exposure assessment for mitigation – Light detection and ranging (DREAM-LiDR) project: the project, which was targeted to complete by December 2013, aims to produce more accurate flood inundation and hazard maps in 3D for the country's flood-prone and major river systems and watersheds.
3) Flood information network (FloodNet) project: targeted to be completed by December 2013 is a flood center that will provide timely and accurate information for flood early warning systems. The FloodNet Project will come up with computer models for the critical river basins; automate the process of data gathering, modeling and information output, and release flood forecasts.

The EFCOS Project Office has responsibility to maintain 3 rainfall gauging stations and 38 water level stations installed by DOST-ASTI in Metro Manila (Pasig-Marikina River, San Juan River and Tullahan River basin).

6.3 Flood Control and EFCOS Project in Greater Metro Manila

Situation of EFCOS Project in the Flood control in the Greater Metro Manila including the provinces of Rizal, Laguna, Cavite and Bulacan is discussed in this section.

(1) Expansion of EFCOS Project to Laguna Lake Basin

Under the Project for Rehabilitation and Warning System in Metro Manila under the Japanese Grant Aid in 2001, expansion of EFCOS Project to the Laguna Lake basin was discussed as follows. In conclusion, a further study is needed on extension in the future.

1) Telemetry Rainfall Gauge Station

Experts concerned have been saying that rainstorms in Metro Manila generally come from the northwest since most typhoons approach Luzon in that direction. If so, rainfall in the Laguna Lake basin, which is located southeast of Metro Manila, could be an indicator of a coming rainstorm. It means that rainfall forecast for Metro Manila could be possible by installing a telemetry system in rainfall gauging stations in

the Laguna Lake basin. At present, however, available rainfall data are still too scarce to examine this hypothesis.

The Laguna Lake had no rainfall gauge in its catchment area for a long time. For the first time in November 1998, LLDA installed five (5) rainfall gauging stations in this area. The purpose of these stations is to study water balance in the lake. Since the rainfall gauges are all automatic recording systems and not telemeterized systems, they are not used directly for flood forecasting purposes. After a few years' observation, however, the accumulated rainfall data could be used for the study on movement of rainfall areas and may provide ideas to determine the necessity of telemetry rainfall stations. Hence, this issue needs to be discussed further after a few years.

2) Telemetry Water Level Station

One of the typhoon-induced problems along the lakeside areas is **seiche**, which is a sudden fluctuation of water level caused by storing winds and/or low atmospheric pressure. In November 1995, the worst seiche took place in the lake during Typhoon Rosing. Fluctuation of the lake water level and the track of Typhoon Rosing from November 2 to 4, 1995. At Angono the lake water began to be forced back into the lake by strong winds and low atmospheric pressure around 3:00 a.m. on the 3rd of November. The water level which was 12.6 m at 0:00 a.m. went down to the minimum level, 10.8 m at 11:00 a.m. Then, the lake water began to return towards Angono, and rose to reach 13.5 m at 3:00 p.m. The fluctuation range on this day was as large as 2.7 m.

According to EFCOS officials, the sudden water level rise had caused severe damage to lakeside areas in the Laguna and Rizal provinces. However, water level data have been so scarce that fluctuation of water level in the lake could not be generally identified.

A seiche like the one in 1995 would possibly occur again. However, the existing Angono telemetry water level gauge cannot cover all the 900 km^2 lake surface area, and it is very difficult to monitor such a seiche by only one telemetry gauging station. Even in Lake Biwa in Japan with a water surface area of 670 km^2, which is slightly smaller than that of the Laguna Lake, there are six (6) telemetry water level gauges. It is recommended that the telemetry system for water level gauges in the Laguna Lake be augmented in the future.

(2) Study on Pasig-Marikina River and Laguna Lake Basin in the Report on Data Collection Survey on Situation of Nationwide Flood Forecasting and Warning System Conducted by JICA for PAGASA (September 2013)

It should be noted that several monitoring systems already have been established in the Pasig-Marikina River and Laguna Lake basin such as EFCOS, KOICA and NOAH. Further, other initiatives of the UNDP/AusAID (Ready for GMMA) and the UNDP/CIDA (Resilience Project) also include components of flood early warning system in the basin. PAGASA is currently integrating all initiatives under KOICA, CIDA, AusAID, and EFCOS to issue flood information for all stakeholders. PAGASA envisages monitoring of all hydrometeorological data in the GMMA to be shared with LGUs. Under such circumstances, in particular, the following development needs should be taken into consideration:

Future Development Needs

	Job Category	Future Development Needs
1	Assessment and Update of Flood Warning Water Levels	• Uniform definitions of warning water levels shall be applied. Substantial review and update of water levels based on the recent occurrence of floods is essential at key monitoring stations.
2	Flood Forecasting	• Flood runoff model has been developed by UP under the Project NOAH. PAGASA will need to judge whether it is

		usable for flood forecasting proposes or not. • Expansion/updating of existing flood runoff models. • Development of IFAS (Integrated Flood Analysis System). • Development of inundation analysis model.
3	Issuance of Flood Information	• Clear demarcation of responsibility between MMDA and PAGASA for issuance of flood information and warning shall be examined and fixed. • Flood information issued by MMDA or PAGASA shall be examined together with development of the integrated data. • Data/information sharing system among agencies shall be re-established. • Development of more reliable means for rapid transmission of flood information. • Operation manual for utilization of EFCOS and KOICA is necessary.
4	Public Information and Education Drive	• Coordination with PAGASA-HMD, OCD, MMDA and LGUs shall be strengthened. • Experiences in the resilience Project shall be repeated with LGUs.
5	Telemetry and Telecommunication	• Integration of NOAH's stations under PAGASA-HMD with shifting ASTI's function including human resources to PAGASA (if required).

(3) O&M of Proposed Marikina Control Gate Structure (MCGS)

A control structure of the Marikina Control Gate Structure (MCGS) in the Marikina River between Rosario Bridge and Rosario Weir is proposed to ensure the flood diversion capacity towards the Mangahan Floodway under the Pasig-Marikina River Channel Improvement Project. Harmonious and effective operation of the three structures, as well as a retarding basin in the upstream areas and Marikina dam development, is one of the emerging issues in the flood control of Pasig-Marikina River. In future, the EFCOS Project will manage the operation and maintenance of MCGS as well as Rosario Weir and Napindan HCS.

(4) World Bank Report for Master Plan for Flood Management

The government, with the technical and financial support of the World Bank, has prepared a Master Plan for Flood Management in Metro Manila and Surrounding Areas in 2012. The plan, approved by the National Economic and Development Authority (NEDA) Board on September 4, 2012, determines a set of priority structural and non-structural measures to provide sustainable flood management up to a certain safety level. The total estimated cost for the implementation of the Master Plan is about PhP352 billion (about US$8 billion) over a 20-25 year period. The main elements of the Master Plan are:

1) Structural measures to reduce flooding from river systems that run through the city;
2) Structural measures to eliminate long-term flooding in the flood plain of Laguna de Bay;
3) Structural measures to improve urban drainage;
4) Non-structural measures such as flood forecasting and early warning systems and community-based flood risk management;
5) Improved institutional structure to deal with flood management in an integrated manner.

The above-4) recommended the early implementation of the following prioritized projects. The details are not described in the report and those are enumerated in the recommendations.

- Improvement of monitoring and telecommunication equipment of EFCOS
- Extension of coverage of monitoring and telecommunication system to the Laguna Lake basin and the Malabon-Tullahan River basin for PAGASA.

7. PREPARATION OF DRAFT OPERATION AND MAINTENANCE PLAN OF EFCOS PROJECT

The following activities were made for the preparation of draft O&M Plan.

(1) Site Inspection

In order to confirm the present status/condition of operation and maintenance works, site inspections were carried out between January 18 and 22.

(2) Confirmation on the present O&M system, structural organization (positions and responsibilities) and budget allocation.

(3) Clarification of existing issues on O&M and evaluation of existing condition of EFCOS Office and O&M methodology.

1) Operation and maintenance of EFCOS Project, Mangahan Floodway and Napindan HCS is supervised by one MMDA-Director. This organizational system is strongly acceptable to avoid the complicated O&M works.
2) Number of major engineers is not sufficient, as mentioned in the 2014 Report for detailed survey.
3) Yearly budget requirement was not prepared previously.
4) Major operation works of the EFCOS Project were rainfall/water level data collection and transmission to the agencies concerned including gate operation. Flood forecasting work was not implemented.
5) Accordingly, flood information from EFCOS to MMDA-FCIC are only rainfall/water level data. Since the flood forecasting information is not included to the FCIC, flood information of FCIC might be insufficient to public.
6) Navigation lock of Napindan HCS is not operational due to damage. DPWH has taken some actions for repairing.
7) Gate operation record of Napindan HCS is not sufficient. Record of gate operation of Napindan HCS should be included in the Yearly Report of the EFCOS Project.

(4) Components of O&M Plan (draft)

In order to ensure sustainable and proper operation of EFCOS in a long term, MMDA shall take necessary measures to increase and sustain the technical and financial capacity of the EFCOS office. Draft O&M Plan is basically composed of the following:

1) Introduction (necessity and objectives f the EFCOS Project, phased project implementation, necessity and review of O&M Plan, O&M Manuals, etc.)
2) Configuration of the EFCOS Project

3) Operation of the EFCOS Project (operation rule of gates, operation of flood warning along Mangahan Floodway, flood forecasting, flood information for dissemination)
4) Plan of maintenance works
5) Organization
6) Plan of yearly budget requirement
7) Related projects (KOICA, Resilience Project, Project NOAH, GMMA Project)
8) Future development

(5) Preparation of draft O&M Plan (herewith attached as **ANNEX-1**)

8. SEMINAR/WORKSHOP ON OPERATION AND MAINTENANCE OF FLOOD FORECASTING AND WARNING SYSTEM IN METRO MANILA

A seminar/workshop was held with national government agencies (MMDA, PAGASA, NEDA, DPWH, OCD, DOST-ASTI, NTC, LLDA) and JICA Philippines Office on O&M of Flood Forecasting and Warning System in the Metro Manila on February 18, 2016, in cooperation of MMDA Training Center and EFCOS Project Office. The following is the program and participants list. Presentation materials directly related to the EFCOS Project are attached as ANNEX-2a, -2b, and -2c.

Seminar/Workshop On the Operation and Maintenance of Flood Forecasting and Warning System in Metro Manila		
Time : February 18, 2016; 13：15 － 16：00		
Place：Makati City Room, MMDA Main Building (EDSA Guadalupe, Makati City, Metro Manila)		
Program		
Item	Presentation	Real Time
1. Registration		12:30-13:20
2. Philippine National Anthem & National Anthem of Japan		13:20
3. Invocation		13:25
4. Opening Remarks	Mr. Emerson S. Carlos Chairman, MMDA	13:30-13:35
5. Message from JICA	Mr. Takahiro Morita Senior Representative, JICA Philippines Office	13:35-13:40
6. MMDA Maintenance Works on Flood Control Facilities	Engineer Baltazar N. Melgar Director IV, MMDA-FCSMO (Flood Control and Sewerage Management Office)	13:40-13:50
7. Outline of EFCOS Improvement/Restoration Project (**ANNEX-2a**)	Engineer Maxima M. Quiambao Director III, Head of EFCOS Project	13:50-14:25
8. Outline of Establishment of EFCOS Website	Mr. Francis Funa Consultant of CTII for DPWH-Pasig Marikina River Channel Improvement	14:25-14:50

	Project (Phase III)	
9. Utilization of EFCOS Data for Disaster Management (**ANNEX-2b**)	Mr. Ramon J. Santiago Head of MMDA-FCIC/MMDRRMOC (Flood Control Information Center/Metro Manila Disaster Risk Reduction and Management Operation Center)	14:50-15:00
10. Outline of Operation of PAGASA's Flood Forecasting and Warning System in Metro Manila (**ANNEX-2c**)	Engineer Maximo Peralta PAGASA-HMD (Hydrometeorology Division)	15:00-15:40
11. Open Forum （Summary of Question/Comments） • DPWH has a plan to construct a dam in the upper Marikina River. In this case, how about EFCOS Project? – (answer) EFCOS Project system will be adjusted depending on the change. • What is Datum line of EFCOS Project, KOICA2, Project NOAH for water level gauging stations? – (answer) EFCOS and KOICA2 use the same datum line (Mean Low Low Water Level = EL.10.0 m). Project NOAH is not clear. • How about telecommunication between PAGASA Monitor Station and DPWH Monitor Station under the EFCOS Project? (answer) Due to the existing high building, PAGASA and DPWH cannot telecommunicate. Presently it is proposed that they connect via Napolcom's tower. PAGASA and Napolcom will make a Memorandum of Understanding on this matter.		15:40-15:50
12. Closing Remarks	Undersecretary Corazon T. Jimenez General Manager, MMDA	15:50-16:00

The following agencies concerned were attended. Total participants are 71.

	Office	Participants
1.	PAGASA (Philippine Atmospheric, Geophysical, and Astronomical Services Administration)	2
2.	OCD (Office of Civil Defense)	3
3.	LLDA (Laguna Lake Development Authority)	1
4.	NTC (National Telecommunication Committee)	1
5.	NEDA (National Economic and Development Authority)	3
6.	DPWH (Department of Public Works and Highway)	2
7.	DOST-ASTI (Department of Science and Technology – Advanced Science and Technology Institute)	2
8.	JICA Philippines Office	4
9.	JICA Expert	4
10.	MMDA (Metropolitan Manila Development Authority)	50
11.	Japan Radio Co., Ltd. (Contractor)	4

Seminar Conducted on Feb. 18 (1)

Seminar Conducted on Feb. 18 (2)

9. STAFF TRAINING ON COMPLETED IMPROVEMENT/RESTORATION PROJECT

On the completion of the improvement/restoration works of the EFCOS Project, staff trainings are conducted at the EFCOS Project meeting/training room on the following schedule by the by the contractor (Japan Radio Co., Ltd.) engineers. Program of training are mainly for the newly installed equipment.

	Day	Time	Program	For
1st Day	February 19, 2016	9:00-12:00	Outline of Rehabilitation Works and Subsystem	MMDA(EFCOS Project Office）:27 staff
		13:00-14:00	Detailed Explanation of Pressure Type and Float Type Water Level Gauge	
		14:00-15:00	Detailed Explanation of Rain Gauge Sensor	
		15:00-17:00	Detailed Explanation of DMP(Data Memory Package) Recorder and DMP Reader Software	
2nd Day	March 1, 2016	9:00-11:00	Detailed Explanation of IP Radio Equipment	MMDA(EFCOS Project Office and other Offices concerned）
		11:00-12:00	Hands on for IP Radio	
		13:00-14:00	Detailed Explanation of Network	
		14:00-17:00	Operator's Training for Website Monitoring and Reporting of EFCOS Data	MMDA (EFCOS Project Office and other Offices concerned),OCD,DPWH,PAGASA
3rd Day	March 2, 2016	9:00-10:30	Detailed Explanation of Telemetry Equipment	MMDA(EFCOS Project Office and other Offices concerned）
		10:30-12:00	Detailed Explanation of Power Supply	
		13:00-15:00	Detailed Explanation of Warning Equipment	

		15:00-16:00	Detailed Explanation of 150MHz band Radio Equipment	

Training on Feb. 19, 2016 (1)

Ongoing Training on Feb. 19, 2016 (2)

10. PREPARATION AND SUBMITTAL OF REPORT ON ACTIVITY ACCOMPLISHMENT IN THE PHILIPPINES

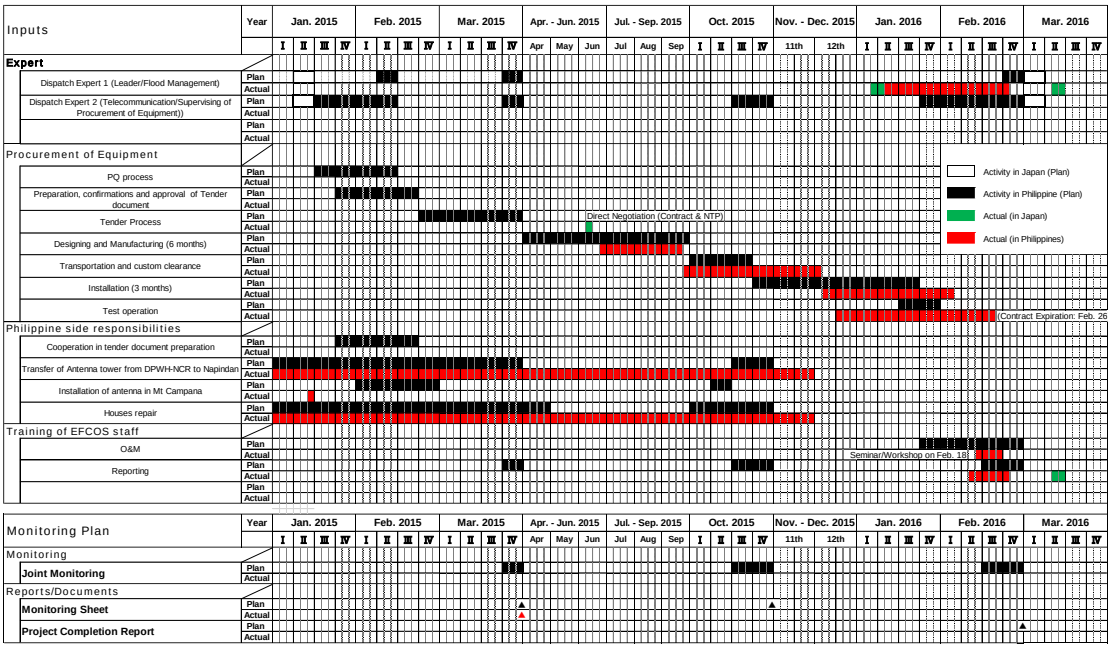
Report on services activities conducted in the Philippines was prepared and submitted to the JICA Philippines Office on February 24, 2016.

11. ACTUAL IMPLEMENTATION SCHEDULE OF IMPROVEMENT/ RESTORATION PROJECT

Implementation schedule of the improvement/restoration project is presented based on the Plan of Operation attached on the Memorandum of Understanding. The Project has been completed in March 2016, as scheduled.

Plan of Operation

Project Title: Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS Project)



12. NOTABLE POINTS AND ISSUES OF EFCOS PROJECT

(1) PAGASA has also being established the flood forecasting and warning system for the flood of Pasig-Marikina River basin with technical assistance of KOICA. Website of PAGASA shows the alert, alarm and critical water levels and real time water levels, including data of EFCOS Project. In the future, it may be necessary to coordinate the flood forecasting and warning system between the EFCOS and PAGASA.

(2) On the completion of the improvement/restoration works, the increase in major staff of the EFCOS Project should be necessary for sustainable and effective operation and maintenance works.

(3) The EFCOS Project Office should prepare the plan of budgetary requirement for 5-year until 2020 for sustainable and effective operation and maintenance works.

(4) A flood forecasting system based on the observed/forecasted rainfall is essential for not only the operation of existing flood control structures such as Rosario Weir but also the overall management in Metro Manila. There are two approaches to utilize flood forecasting information for the flood management in Metro Manila:

   a) To utilize the forecasted data produced by the existing flood forecasting system of PAGASA through sharing the observed rainfall and water level data of EFCOS and PAGASA; and

   b) To establish a new flood forecasting system using license-free software, such as the HEC model of US Army Corps of Engineers, under the related large project, Pasig-Marikina River Channel Improvement Project.

(5) In order to operate the gates of Napindan HCS effectively, navigation lock should be repaired. According to the DPWH, DPWH have already taken necessary actions for repairing lock. The EFCOS Project Office should monitor it closely.

REPUBLIC OF THE PHILIPPINES

METRO MANILA DEVELOPMENT AUTHORITY (MMDA)

EFFECTIVE FLOOD CONTROL OPERATION SYSTEM (EFCOS PROJECT)

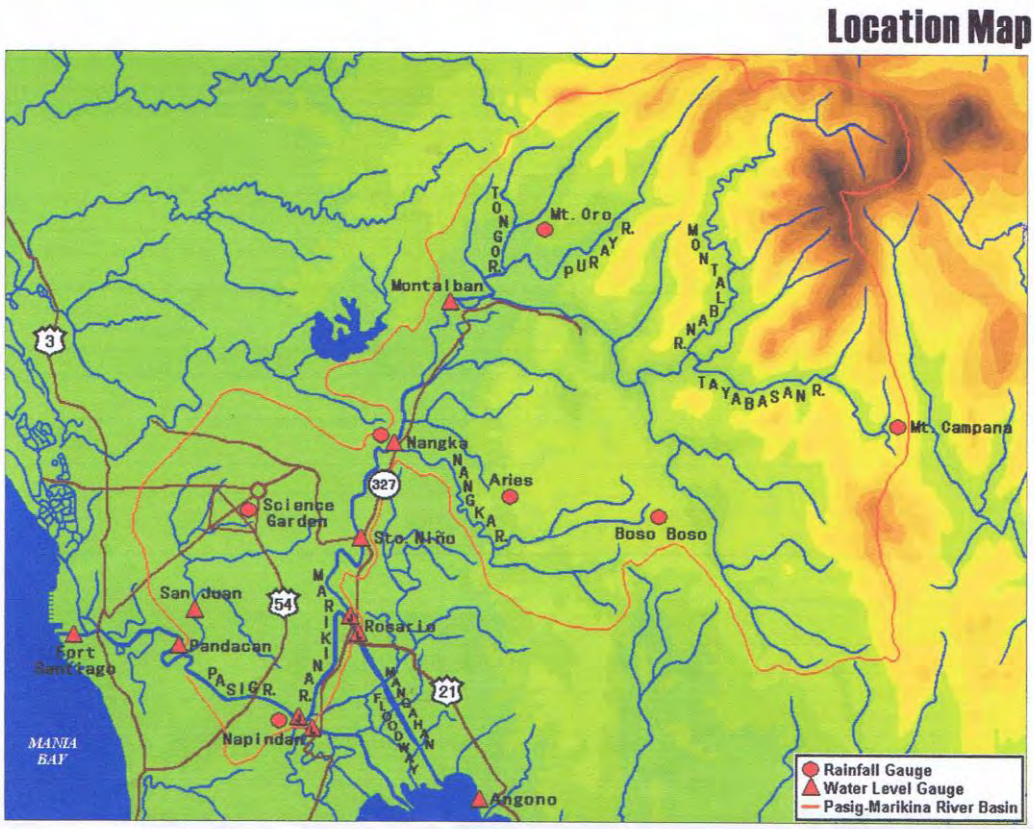
OPERATION AND MAINTENANCE PLAN

(DRAFT)

MARCH 2016

FLOOD CONTROL AND SEWERAGE MANAGEMENT OFFICE

EFCOS PROJECT OFFICE



EFCOS Rosario Master Control Station and Rosario Well

Table of Contents

CHAPTER 1. INTRODUCTION

1.1 Necessity of the EFCOS Project

As part of the Metro Manila Flood Control and Water Resource Development Projects, the Mangahan Floodway and Napindan Hydraulic Control Structure (HCS) were completed in 1988 and 1983, respectively.

The efficiency and effectiveness of the Mangahan Floodway depends on the integrated, synchronized operation of the two control facilities above. There is a certain chance of danger of failure in the operation that may cause a serious man-made flooding. In order to avert any such error in the manipulation of the control structures, it is imperative to establish/set-up an effective procedure for flood control operation and subject facilities.

A reliable and effective telemetering and warning system was necessary for the flood control operation. Therefore, the construction of Mangahan Floodway Project gave emphasis to the formulation of an effective telemetering and warning system, EFCOS Project. To attain this, the **Feasibility Study** on EFCOS Project, as a part of construction of Mangahan Floodway project, was conducted in 1981.

During the time between the completion of Mangahan Floodway in 1988 and the completion of EFCOS Project in 1993, the Rosario Weir for the flood diversion into Laguna Lake through Mangahan Floodway was operated based on the on-site observation of the water level of Marikina River at Rosario Weir.

With the EFCOS Project, through the weather forecast and flood information, real time hydrological data and analysis, the Rosario Master Control Station can estimate and determine the effective flood diversion operation at Rosario Weir. It also enables the gate operation of Napindan HCS, which is another inlet/outlet gate of Laguna Lake.

Warning system along the Mangahan Floodway is provided to prevent man-made calamity in consideration of the abrupt rises of the water level in the Mangahan Floodway.

1.2 Rehabilitation and Improvement Works of the EFCOS Project

After completion in 1993, the EFCOS Project was improved and rehabilitated twice in 2001 and 2016. As a matter of convenience, they are called as follows:

Phase 1 : original project completed in 1993 (Feasibility Study in 1981 and Detailed Design in 1985), under Overseas Economic Cooperation Fund (OECF) loan package of Japan.

Phase 2 : Project for the Rehabilitation of the Flood Control Operation and warning System in Metro Manila completed in December 2001, under the Japan's Grant Aid Program.

Phase 3 : Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS) completed in February 2016, under JICA's Technical Cooperation Program.

(1) Project for the Rehabilitation of the Flood Control Operation and Warning System in Metro Manila

The EFCOS system designed in 1985 was an analogue telemetry system, and it was practically unable to function as a flood forecasting system. Data were input manually into the computer to calculate water discharge and, therefore, no time allowance was made to provide for advanced flood information. Furthermore, the meteorological and hydrological monitoring network was inadequate.

In this circumstances, the Government of the Philippines (GOP) improved and enhanced the overall function of the EFCOS Project established in 1993 under the Japan's Grant Aid program, which was completed in December 2001. The Project included:

a) Construction of additional hydrological observation stations (2 water level gauging stations and 5 rainfall gauging stations),
b) Installation of digitized telemetry system as well as on-line data processing system,
c) Introduction of flood forecasting system,
d) Radio communication system needed to be installed at pumping stations, LGUs and other agencies concerned for sharing flood-forecasting information,
e) Visual images for display of data collected.

(2) Transfer of Operation and Maintenance of Flood Control Facilities from DPWH to MMDA

Flood control in Metro Manila in which EFCOS Project is a component was transferred to MMDA from DPWH on August 2002. However, due to unavoidable circumstances and lots of strong typhoons that hit the entire Metro Manila and nearby provinces, some of the monitoring and relay stations were damaged and not operational and that temporary repair did not materialized due to MMDA budgetary constraints.

On May 2, 2008, there was an order from the MMDA Main Office to close EFCOS Project Office and remain all the gates open at Rosario Weir and Napindan HCS. Although the operations on the said gates were to remain open, maintenance and data gathering at the telemetry gauge stations still continued.

(3) Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS)

In recent years, floods brought about by typhoons and monsoonal storms occur more frequently than before in Metro Manila; therefore rehabilitation of the EFCOS has become an urgent and critical issue. With this situation, the GOP requested Japanese Government for assistance to "Project for the Improvement/Restoration of Telemetry Equipment of the Effective Flood Control Operation System (EFCOS)" with the aim to restore the function of EFCOS by rehabilitating the damaged facilities/equipment.

In response to the request, JICA dispatched a survey mission to the Philippines in July 2014 for the purpose of developing a detailed plan for the Project. The Mission exchanged views and held a series of discussions on damaged facilities/equipment to be repaired/replaced, frequency changes, works to be done by MMDA, etc., with the representatives of relevant organizations. Detailed planning for the restoration project was compiled in the report of Detailed Planning Survey (October 2014).

Results of discussions were concluded as Memorandum of Understanding (MOU) between JICA Mission and MMDA which signed in October 2014. The improvement/restoration project was completed in February 2016.

1.3 Validity of the EFCOS Project

JICA Report on Detailed Planning Survey (2014) mentioned the verification of EFCOS Project as follows:

As observed during flood occurred in 2014 caused by Typhoon Glenda, the EFCOS is still working as a core player in meteorological-hydrological monitoring and telecommunication system during floods, although some parts and equipment were already damaged in the previous typhoons and are deteriorated by aging. The EFCOS could be central in the Metro Manila flood monitoring and telecommunications based on the following observations:

- During onslaught of Typhoon Glenda, only the EFCOS functioned in monitoring rainfall and water levels and sent the data to the Rosario Master Control Station MCS. Although various monitoring and telecommunication systems exist in the Pasig-Marikina River basin, it was verified that the EFCOS Project could be regarded as a suitable and robust system among the others in order to effectively operate the related flood control structures along the river courses.
- Since such kind of telecommunications system was developed in Japan, which is also a flood and typhoon-prone country similar to the Philippines, prioritized requirement for the entire system is high reliability even if slightly costly.
- Therefore, the EFCOS Project is essential to cope with the recurrent floods and to mitigate flood damages because it is closely related to the effective operation of flood control structures along the Pasig-Marikina river course. Furthermore, its importance will increase from the future roles to provide the reliable hydrological data for effective operation of the structures including the Marikina Control Gate Structure (MCGS) which is under planning as a flood control structure in the basin.

1.4 Objectives of the EFCOS Project

The objectives of the EFCOS Project are as follows:

(1) Synchronized operation of Rosario Weir of Mangahan Floodway and Napindan Hydraulic Control Structure (HCS) to mitigate flood damages in the Pasig-Marikina River and Laguna Lake Complex through its telecommunication meteorological-hydrological monitoring and warning system.

(2) Flood warnings are disseminated to residents along the Mangahan Floodway.

(3) Strengthening flood control management including implementation of flood forecasting operations.

(4) Dissemination of data/information on rainfall and water level in the Pasig-Marikina River Basin in order to Local Government Units and other agencies concerned for sharing flood-forecasting information.

1.5 Purpose of Operation and Maintenance (O&M) Plan

The purposes of Operation and Maintenance (O&M) Plan for the EFCOS Project are itemized below:

- To ensure that the facility is operated according to the planning/design of the EFCOS Project
- To extend the useful life of the facilities installed
- To ensure the required quality of meteorological and hydrological data

1.6 Effectiveness of O&M Plan

This O&M Plan is prepared on the basis of the latest Phase 3 (improvement/restoration of telecommunication equipment project completed in February 2016). The established O&M Plan should be reviewed and revised based on the accomplishment of O&M activities, in principle, every 5-year duration.

1.7 O&M Manuals

There are two (2) O&M Manuals which were prepared in Phase 1 (1993) and Phase 2 (2001) for rehabilitated/improved EFCOS Project.

The O&M Manual is:

- To give guidance on O&M Plan
- To give how to operate and maintain the completed project to ensure the effective, efficient and sustainable operation and maintenance.
- A key to an effective O&M performance
- To be also revised/updated on the basis of accumulating O&M activities.

(1) Operations and Maintenance Manual for Nationwide Flood Control and Dredging Project, Part B – An Effective Flood Control Operation System including Telemetering and Flood Warning System in the Pasig-Marikina-Laguna Lake Complex (October 1993).

This was prepared at the time of completion of the original Project and is composed of the following:

a) Institutional Arrangement
b) Flood Operation and Warning Manual
c) Maintenance Manual
d) System Facilities
e) Guidelines of Gate Operation for Mangahan Floodway and Napindan Hydraulic Control Structure in Non-rainy Season
f) Hydrological Data Analysis and Computer Manual

(2) Report on Technical Guidance for the Project for Rehabilitation and Warning System in Metro Manila (March 2002)

This Manual is for the rehabilitated/improved EFCOS which included computer system, telemetry system, warning, multiplex radio and emergency radio system in the Pasig-Marikina-Laguna Lake Complex.

This manual is the revised one of original manual stated above (1) and is composed of the following:

a) *Revised* Institutional Arrangement
b) *Revised* Flood Operation and Warning Manual
c) *Revised* Maintenance Manual
d) *Revised* System Facilities
e) Guidelines of Gate Operation for Mangahan Floodway and Napindan Hydraulic Control Structure in Non-rainy Season (no revision made in original Manual)
f) Hydrological Data Analysis and Computer Manual (partially revision of original Manual based on the system improvement and application of MIKE 11 for flood predict)

CHAPTER 2. CONFIGURATION OF THE EFCOS PROJECT

2.1 Pasig-Marikina River and Laguna Lake Complex

(1) Location of the Project Area

The subjective area is located in latitude $14^0$50'N and longitude $121^0$00'-$121^0$35'E and administratively comprises portions of Metropolitan Manila, Rizal Province and Laguna Province, which are approximately equivalent of the catchment area of Pasig-Marikina River plus Laguna de Bay, about 3,800 km^2 or 1.3% of the total land area of the Philippines. Flooding in the Pasig-Marikina River and Laguna Lake Complex are affected by the interrelationships.

(2) Pasig River-Marikina River – Napindan River - Laguna Lake Watershed

Upper Marikina River runs in the Marikina Valley enclosed by hills and mountain, forming its eastern and western boundaries. The upstream of Marikina Valley is in the Sierra Madre mountain range and the river channel in this area runs in a sharp gorge.

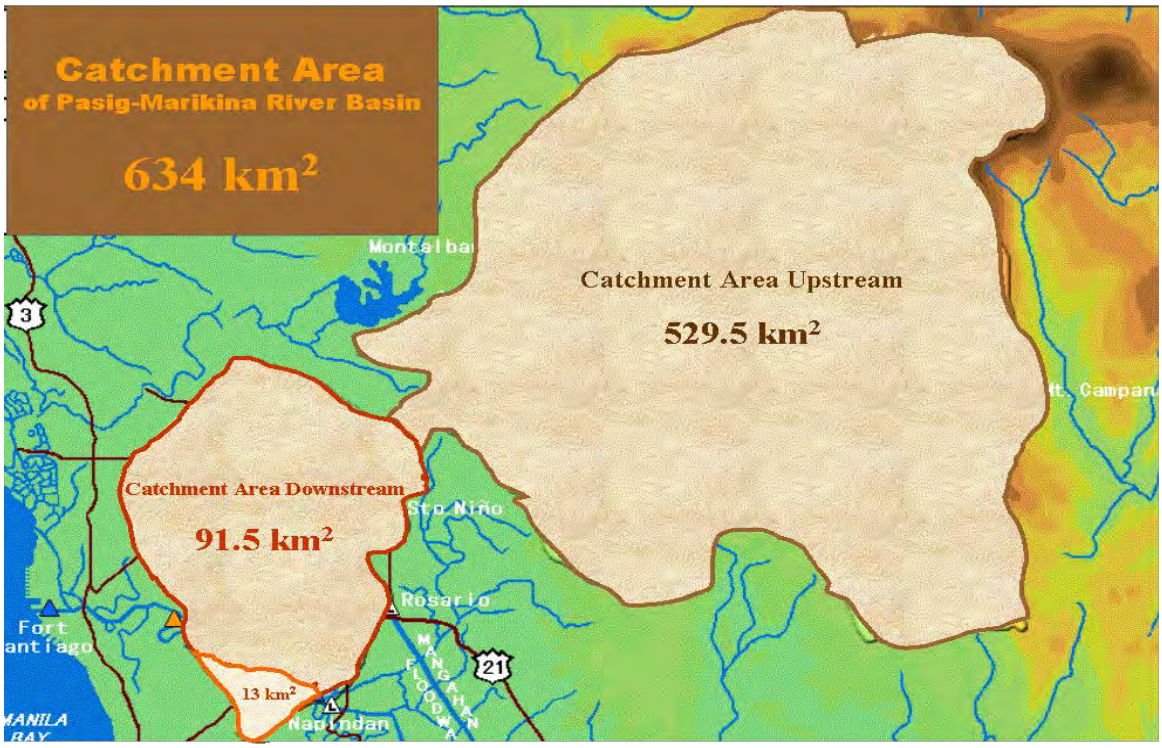
Lower Marikina River is from Rosario Weir to Napindan Channel and its downstream is called Pasig River. This river with a meandering river course flows from east to west into Manila Bay through the heavily urbanized Metropolitan Manila area.

Pasig-Marikina River Basin	634 km^2	
Pasig-Marikina River	from Manila Bay to Montalban Bridge	• 45.5 km long
Marikina River	From Montalban to Napindan Channel	• 27 km long • C.A at Napindan junction: 516.5 km^2 • C.A at Rosario Weir: 505.2 km^2 • C.A at Sto. Nino: 499 km^2 • C.A at Montalban Bridge: 365.5 km^2
- Upper Marikina River	from Montalban bridge to Mangahan Floodway (Rosario Weir)	• 20.5 km long
- Lower Marikina River	from Mangahan Floodway (Rosario Weir) to Napindan Channel	• 6.5 km long
Pasig River	from Napindan Channel to Manila Bay	• 18.5 km long
Napindan Channel	from Laguna Lake to junction point of Pasig River/Marikina River	• 7.5 km long
San Juan River	Largest tributary of Pasig River at 7.15 km upstream from Manila Bay.	• 91.5 km^2 • 8.7 km long
Laguna Lake Basin	Water Surface at El. 11.5m: 900 km^2	• 3,159 km^2 • Shallow depth less than 4 m
Mangahan Floodway	Design Discharge: 2,400 m^3/s 8 gates x 18.75m wide x 3.0m high Total open width: 150m	• 8.5 km long. • Top of gate closed: EL. 14.0m • Bottom of gate closed: EL. 10.5 m • Bank level: EL. 11 to 13.5 m
Napindan HCS	(a) Gated Dam (Steel Roller Gate) 4 gates x 15.0 m wide x 9.0m high Total open width: 60.0 m (b) Lock (Steel Submersible Radial	• Top of gate closed: EL. 15.0m • Bottom of gate closed: EL. 6.0 m • Bank level: EL. 11.0 to 13.5 m

	Gate) 1 gate x 18.0 m wide x 9.0m high	• Top of gate closed: EL. 15.0m • Bottom of gate closed: EL. 6.0 m

Pasig-Marikina River Basin Catchment Area

Name of Structure/River (Reference Point)	Catchment Area (km^2)
Wawa Dam	269.0
Rodriguez Bridge	365.5
Nangka River (Upstream of the junction)	434.3
Marikina Bridge (Sto. Nino)	499.0
Mangahan Floodway (Upstream of the junction)	505.9
Napindan Channel (Upstream of the junction)	516.9
San Juan River (Upstream of the junction)	529.5
Pasig – Marikina River (River mouth)	634.0



Major tributaries of the Upper Marikina Rivers are those joining from the left bank, such as the Burgos Creek, the Ampid Creek and the Nangka River as tabulated below:

Name of River/Creek	Area (km^2)	Distance* (km)
Burgos Creek	27.8	12.05
Ampid Creek	24.4	6.83
Nangka River	51.4	5.66

Note: Distance is from the Marikina Bridge, St. Nino.

(3) Meteorology

The Philippines may be classified into four climatological regions. The Project Area belongs to 1st type, which has two prominent seasons, dry season from November to April and rainy season from May to October.

These meteo-hydrological characteristics are mainly governed by seasonal dominant monsoons, trade winds, tropical cyclones and combinations of them.

Out of them, the tropical cyclone is the most influential to floods in the Project Area. The annual mean tropical cyclones that pass near the Philippines are 19.6 in number. For Central Luzon, the landing rate of tropical cyclones counts for 16 percent.

The meteorological characteristic of the area is dominated by two seasons: the rainy season from June to November and dry season from December to May.

- Northeast monsoons dominates from May to September.
- Tropical Cyclone takes places from July to December.
- Typhoons associated with northeast monsoon brings heavy rainfall which causes flooding.
- Serious flooding usually occurs from August to November.

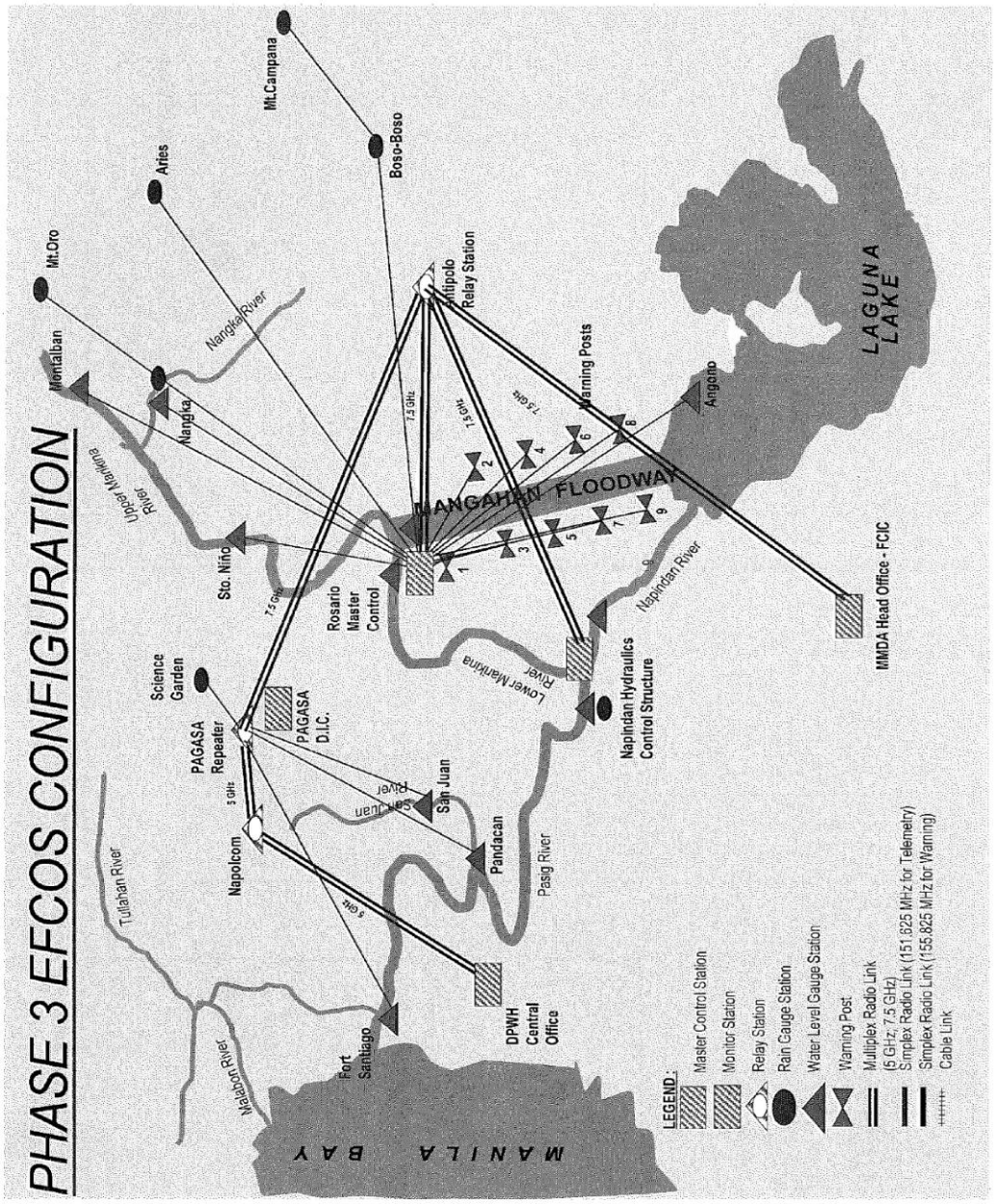
(4) Rainfall

The annual rainfall distribution shows the annual rainfall of more or less 3,000 mm over the high Sierra Madre mountain range where the headwaters of the Marikina River are located. On the other hand, the annual rainfall of approximately 2,000 mm spreads over the rainfall zone of the Manila Bay to the Laguna Lake.

The monthly rainfall distribution, except the western area of the Laguna Lake, accords with that of the first climatological region and have high rainfall months from May to October. The total rainfall of the months counts for about 80 percent of the annual rainfall, and it is brought mainly by the wet southwest monsoon, plus the occasional typhoons. The monthly rainfall distribution over the western area of the Laguna Lake has a longer rainy season up to December. This is because of the influence of the northeast monsoon, which invades the area across the low terrain of the Sierra Madre ranges bordering the first and the second climatological zones.

2.2 Configuration of the EFCOS Project under the Phase 3 Completed in 2016

There are no additional stations constructed under the latest Project completed in February 2016.



Phase 3 Configuration of the EFCOS Project Stations in 2016

2.3 Features of Stations of the EFCOS Project (Phase 3)

The facilities of EFCOS Project are summarized in the following table:

Summary of EFCOS Project Stations

No.	Facility	Installed in	Remarks
(1) Rainfall Gauging Station			
EFCOS-R-1	Boso Boso Rainfall Gauging Station	1993	
EFCOS-R-2	Mt. Oro Rainfall Gauging Station	1993	
EFCOS-R-3	Mt. Campana Rainfall Gauging Station	2001	
EFCOS-R-4	Aries Rainfall Gauging Station	2001	
EFCOS-R-5	Nangka Rainfall Gauging Station	2001	
EFCOS-R-6	Napindan Rainfall Gauging Station	2001	
EFCOS-R-7	PAGASA S.G. Rainfall Gauging Station	2001	
(2) Water Level Gauging Station			
EFCOS-W-1	Montalban Water Level Gauging Station	1993	Marikina River
EFCOS-W-2	Nangka Water Level Gauging Station	2001	Nangka River
EFCOS-W-3	Sto. Nino Water Level Gauging Station	1993	Marikina River
EFCOS-W-4	Rosario J.S. Water Level Gauging Station	1993	Marikina River
EFCOS-W-5	Rosario L.S. Water Level Gauging Station	1993	Mangahan Floodway
EFCOS-W-6	Napindan J.S. Water Level Gauging Station	1993	Marikina River
EFCOS-W-7	Napindan L.S. Water Level Gauging Station	1993	Napindan River
EFCOS-W-8	San Juan Water Level Gauging Station	2001	San Juan River
EFCOS-W-9	Pandacan Water Level Gauging Station	1993	Pasig River
EFCOS-W-10	Fort Santiago Water Level Gauging Station	1993	Pasig River
EFCOS-W-11	Angono Water Level Gauging Station	1993	Laguna Lake
(3) Master Control Station			
EFCOS-MC-1	EFCOS Rosario Master Control Station	1993	
(4) Monitor Station			
EFCOS-MT-1	Napindan HCS Monitor Station	1993	
EFCOS-MT-2	MMDA-FCIC (Flood Information Center) Monitor Station	2016	
EFCOS-MT-3	PAGASA-HMD (Hydrometeorology Division) Monitor Station	1993	
EFCOS-MT-4	DPWH (Central Office) Monitor Station	1993	
(5) Relay Station			
EFCOS-RL-1	Antipolo Relay Station	1993	
EFCOS-RL-2	PAGASA S.G. Relay Station	1993	
(6) Warning Post			
EFCOS-WP-1	Warning Post No. 1	1993	
EFCOS-WP-2	Warning Post No. 2	1993	
EFCOS-WP-3	Warning Post No. 3	1993	
EFCOS-WP-4	Warning Post No. 4	1993	
EFCOS-WP-5	Warning Post No. 5	1993	
EFCOS-WP-6	Warning Post No. 6	1993	
EFCOS-WP-7	Warning Post No. 7	1993	
EFCOS-WP-8	Warning Post No. 8	1993	
EFCOS-WP-9	Warning Post No. 9	1993	
			(Facilities in Total: 34)

(1) Rainfall Gauging Station

No.	Name	Elevation (EL. m)	Coordinate		Location
			Latitude	Longitude	
1	2	3	4	5	6
EFCOS-R-1	Boso Boso	381	14°38'23"	121°13'21"	Barangy Boso Boso, Antipolo, Rizal
EFCOS-R-2	Mt. Oro	64	14°45'48"	121°09'28"	Barangay San Isidro, Montalban, Rizal
EFCOS-R-3	Mt. Campana	450	14°40'01"	121°17'34"	Sitio San Jose, Barangay San Jose, Antipolo, Rizal
EFCOS-R-4	Aries	395	14°39'41"	121°10'14"	Sitio Aries, Barangay Malanday, San Mateo Rizal
EFCOS-R-5	Nangka	23	14°40'28"	121°06'33"	Barangay Banaba, San Mateo, Rizal
EFCOS-R-6	Napindan	15	14°33'27"	121°04'04"	Napindan HCS Compound, Barangay Buting, Pasig City
EFCOS-R-7	PAGASA S.G.		14°38'43"	121°02'40"	Science Garden Compound, BIR Road, Quezon City

(Note) Type of Equipment: Tipping Bucket Type.

(2) Water Level Gauging Station

No.	Name	River & Distance from Rosario Weir	Coordinate		Location	Type & Range of Equipment
			Latitude	Longitude		
1	2	3	4	5	6	7
EFCOS-W-1	Montalban	Upper Marikina 21.0 km	14°44'06"	121°07'39"	Amang Rodriguez Bridge, Montalban, Rizal	Float Type Gauge: Range EL.18.7m to EL.30.0m
EFCOS-W-2	Nangka	Nangka 12.0 km	14°40'28"	121°06'33"	Near Nangka Bridge, Barangay Banaba, San Mateo, Rizal	Float Type Gauge: Range EL.18.7m to EL.25.0m
EFCOS-W-3	Sto. Nino	Upper Marikina 6.7 km	14°38'15"	121°05'33"	Marikina Bridge, Brgy. Sto. Nino, Marikina, MM	Float Type Gauge: Range EL.9.8m to EL.22.8m)
EFCOS-W-4	Rosario J.S.	Upper Marikina 0.0 km	14°36'00"	121°05'16"	Amang Rodriguez, Barangay Rosario, Pasig City	Range EL.10.0m to EL.18.5m)
EFCOS-W-5	Rosario L.S.	Mangahan FW 0.0 km	14°36'00"	121°05'16"	Amang Rodriguez, Barangay Rosario, Pasig City	Pressure Type Gauge: Range EL.-10.0m to EL.18.5m
EFCOS-W-6	Napindan J.S.	Pasig 6.5 km	14°33'32"	121°04'01"	Napindan HCS Compound, Barangay Buting, Pasig City	Float Type Gauge Range: EL.?m to EL.16.0m
EFCOS-W-7	Napindan L.S.	Napindan 6.5 km	14°33'32"	121°04'01"	Napindan HCS Compound, Barangay Buting, Pasig City	Float Type Gauge Range: EL.?m to EL.16.0m
EFCOS-W-8	San Juan	San Juan	14°36'01"	121°01'28"	San Juan Elementary School, A. Luna St., San Juan City	Float Type Gauge Range: EL.9.5m to EL.16.0m
EFCOS-W-9	Pandacan	Pasig 16.5 km	14°35'28"	121°00'40"	Pandacan Independent Floodgate, Pandacan, MM	Float Type Gauge Range: EL.9.7m to EL.14.1m
EFCOS-W-10	Fort Santiago	Pasig 22.8 km	14°35'49"	121°58'07"	Port Area, Manila	Float Type Gauge Range: EL.9.7m to EL.13.0m
EFCOS-W-11	Angono	Laguna Lake 10.0 km	14°31'28"	121°08'27"	Mabuhay Resort House, Angono, Rizal	Float Type Gauge Range: EL.9.8m to EL.17.1m

(Note) Datum Line (DL) = EL.0.0m, Mean Lower Low Water Level (MLLW) = EL.10.0m, Mean Sea Level (MSL) = EL.10.46m.

(3) Warning Posts along Mangahan Floodway

No.	Location			Coordinate		Elevation (EL. m)
	Station of MF	Bank	Distance*	Latitude	Longitude	
1	2	3	4	5	6	7
EFCOS-WP-1	Rosario MCS	West	0.00	14º36'00"	121º05'16"	+18.0
EFCOS-WP-2	Sta. 2+200	East	2.20	14º34'56"	121º05'50"	+16.5
EFCOS-WP-3	Sta. 3+300	West	3.30	14º34'20"	121º06'03"	+18.0
EFCOS-WP-4	Sta. 4+400	East	4.40	14º33'57"	121º06'31"	+18.0
EFCOS-WP-5	Sta. 5+350	West	5.35	14º33'27"	121º06'42"	+16.0
EFCOS-WP-6	Sta. 6+300	East	6.30	14º33'07"	121º07'07"	+16.0
EFCOS-WP-7	Sta. 7+250	West	7.25	14º32'36"	121º07'18"	+15.5
EFCOS-WP-8	Sta. 8+200	East	8.20	14º32'16"	121º07'43"	+15.0
EFCOS-WP-9	Sta. 8+450	West	8.45	14º32'04"	121º07'40"	+15.0

Note: *Distance from Rosario Master Control Station (km).

(4) Master Control Station, Monitor Station and Relay Station

No.	Name	Location	Coordinate		Elevation (EL. m)
			Latitude	Longitude	
1	2	3	4	5	6
EFCOS-MC-1	EFCOS Rosario Master Control Station	Amang Rodriguez, Barangay Rosario, Pasig City	14º36'00"	121º05'16"	+15
EFCOS-MT-1	Napindan HCS Monitor Station	Napindan HCS Compound, Barangay Buting, Pasig City	14º33'32"	121º04'01"	
EFCOS-MT-2	MMDA-FCIC (Flood Information Center) Monitor Station	Metro Base, MMDA Bldg., Orenza St., EDSA Guadalupe, Makati City	14º33'45"	121º02'30"	+20
EFCOS-MT-3	PAGASA-HMD Monitor Station	BIR Road, Dillman, Quezon City			
EFCOS-MT-4	DPWH (Central Office) Monitor Station	Bonifacio Drive, Port Area, City of Manila	14º35'23"	120º58'12"	
EFCOS-RL-1	Antipolo Relay Station	Town and Country Subdivision, Antipolo, Rizal	14º36'46"	121º08'44"	+110
EFCOS-RL-2	PAGASA S.G. Relay Station	Science Garden Compound, BIR Road, Quezon City	14º38'45"	121º02'35"	+50

CHAPTER 3. PLAN OF OPERATION OF THE EFCOS PROJECT

3.1 Gate Operation Rule of Rosario Weir

3.1.1 General

The Gate Operational Rule was established in Phase 1 (1993) upon the completion of the EFCOS Project, and the Rule was updated in Phase 2 (the *Project for Rehabilitation project of the Flood Control Operation and Warning System in Metro Manila*) in March 2002. The Rule was formulated, based on the relationship among tidal level monitored at Fort Santiago Gauging Station, water levels at Sto. Nino Gauging Station and Montalban Gauging Station.

3.1.2 Data Processing System

The following functions are in the online processing subsystems:

(1) This subsystem automatically collects and processes information on the telemeter system, Rosario Weir, and Napindan HCS Gate operations. It also computes rainfall in 10, 15 and 30 minutes, 1 hour, and accumulative rainfall and converts the water level to the discharge. In addition, it has an automatic computing function for their statistical data, such as minimum, average and maximum in day, month, and year.
(2) This subsystem accumulates processed data into three kinds of database files and automatically renews the database when new data are collected.
(3) This subsystem reads data in a memory pack in which raw observed rainfall or water level data are stored as a backup of the telemetry system and compensates/corrects missing data in the basic database.
(4) This subsystem works out reports (daily, monthly, annual reports and operation logs) based on the processed.

Data to be Collected

Data	Nos. Data	Collection Frequency	Information
Rainfall	7 Stations	Usually, the data collection interval is every hour. The interval can be changed to every 10, 15, or 30 minutes.	• Time of observation: year, month, day, hour, minute. • Total rainfall from the previous observation.
Water-level	11	Usually, the data-collecting interval is every hour. The interval can be changed to every 10, 15, or 30 minutes.	• Time of observation: year, month, day, hour, minute. • Total rainfall from the previous observation.
Gate information (Rosario weir: total 8 gates, Napindan weir: total 4 gates)	12	At gate operation	• Time of gate operation: year, month, day, hour, minute. • Status after operation

3.1.3 Operation Rule of Rosario Weir

Planning/design of Rosario Weir is explained as follows:

(1) Original Purpose of Rosario Weir

BPW Master Plan for the Drainage of Manila and Suburbs (1952) stated that "The most serious obstacle to the realization of this scheme (construction of floodway) will be the objections of towns bordering the lake, based on the fear that the lake level will rise substantially as a result thereof. It should be pointed out that it is not intended to close the Marikina River and divert its flow completely into the lake. The proposed channel will not be excavated to the same depth as the bed of the Marikina River. The bottom of the channel at the point of diversion will be kept permanently at elevation 13.00 m or 3 meters above the bed of the Marikina River *(by construction of Rosario Weir at the entrance of Floodway).* Only when the flow in the Marikina River exceeds this depth, will there be flow in the proposed channel".

(2) Original Structural Design under the Feasibility Study of Mangahan Floodway Project

The original design of Rosario Weir is a concrete ogee shape crest weir that will pass 2,400 m^3/s with a head over the weir of 3.85 m. by building the weir crest at elevation 14.0 m, and by operating the MCGS properly, a water surface upstream from the weir of 17.85 m is provided. The ogee weir crest is 126 m long.

(3) Deferment of Construction of MCGS and Re-design of Rosario Weir

In 1979, Ministry of Public Works (MPW) determined the indefinite deferment of the construction of the MCGS related to the navigation in the Marikina River and instead, its function of controlling diversion of the floodwater of the Marikina River, achieved by the operation of a re-designed Rosario Weir with movable full gate, up to 2,000 m^3/s floods even without the MCGS before the improvement of Upper Marikina River.

Also, the re-design to a fully movable gate structure was intended to examine the function of Rosario Weir in lowering the flood level in the Laguna Lake by allowing reverse flow through the floodway channel.

As a solution to alleviate flooding conditions of long duration that cause heavy damage to the lakeshore areas, the MPW conceived of the idea of reversing the flow of water from Laguna Lake to Marikina River during high lake water stages and will, therefore, necessitate the redesign of the Rosario Weir.

The latest operation rule is the one revised in 2012 considering the actual development conditions along the Pasig-Marikina River and Laguna Lake Complex.

(1) (**Pre-caution Stage**) During the **pre-caution stage** of flood, all gates are usually closed but then an announcement is given to persons within the Floodway Channel as a pre-cautionary measure. This stage occurs when water level at Sto. Nino Water Level Gauging Station on the Marikina Bridge is more than its alert level of **EL. 13.0 m** corresponding to 150 m^3 discharge and when the Basin Average Rainfall Intensity is **more than 30 mm**, or in case the water level at Montalban Water Level Gauging Station exceeds **EL. 22.4 m** corresponding to 100 m3 per second.

(2) (**Caution Stage**) Once the flood water level at Sto. Nino Water Level Gauging Station reaches at **EL.13.8 m**, the gates of Rosario Weir are to be opened sequentially from the center one in accordance with water level rising at Sto. Nino Water Level Gauging Station.

When Caution Stage starts, some floodgates are open causing the sudden increase of floodwater,

to flow in the Floodway Channel. Warning consisting a siren warning and speaker warning is issued around **30 minutes before** the opening of the gates of Rosario Weir to provide enough time for people to stay away from the Channel.

- The Napindan HCS is closed and the Rosario Weir is operated for opening only to store the flood water from Marikina River into Laguna Lake.
- This Caution Stage occurs when the water level at Sto. Nino Water Level Gauging Station reach **Critical Level 1 (EL.13.8 m to 13.9 m)** hence, **two (2) gates** of Rosario Weir are open.
- But, when the water level comes up halfway between **Critical Level 1 (EL.13.8 m to 13.9 m) and Critical Level 2 (EL.14.0 m to 14.4 m) four (4) gates** are open simultaneously.
- when the water level comes up halfway between **EL.14.5 m to 15.1 m, six (6) gates** are open simultaneously

(3) (**Emergency Stage**) When the flood water level at Sto. Nino Water Level Gauging Station reaches at **EL.15.3 m**, **all the gates** are to be opened.

(4) (**Subsiding Stage/ Post Flood Stage**) After passing the flood peak through Sto. Nino Water Level Gauging Station and the flood water level is **below 15.0 m**, the opened gates are to be closed in accordance with water level subsiding at Sto. Nino Water Level Gauging Station.

Elevation of Critical Water Level 1 and 2 vary depending on the tidal level of Manila Bay observed at Fort Santiago Water Level Gauging Station.

The Above-rules are summarized in the following tables:

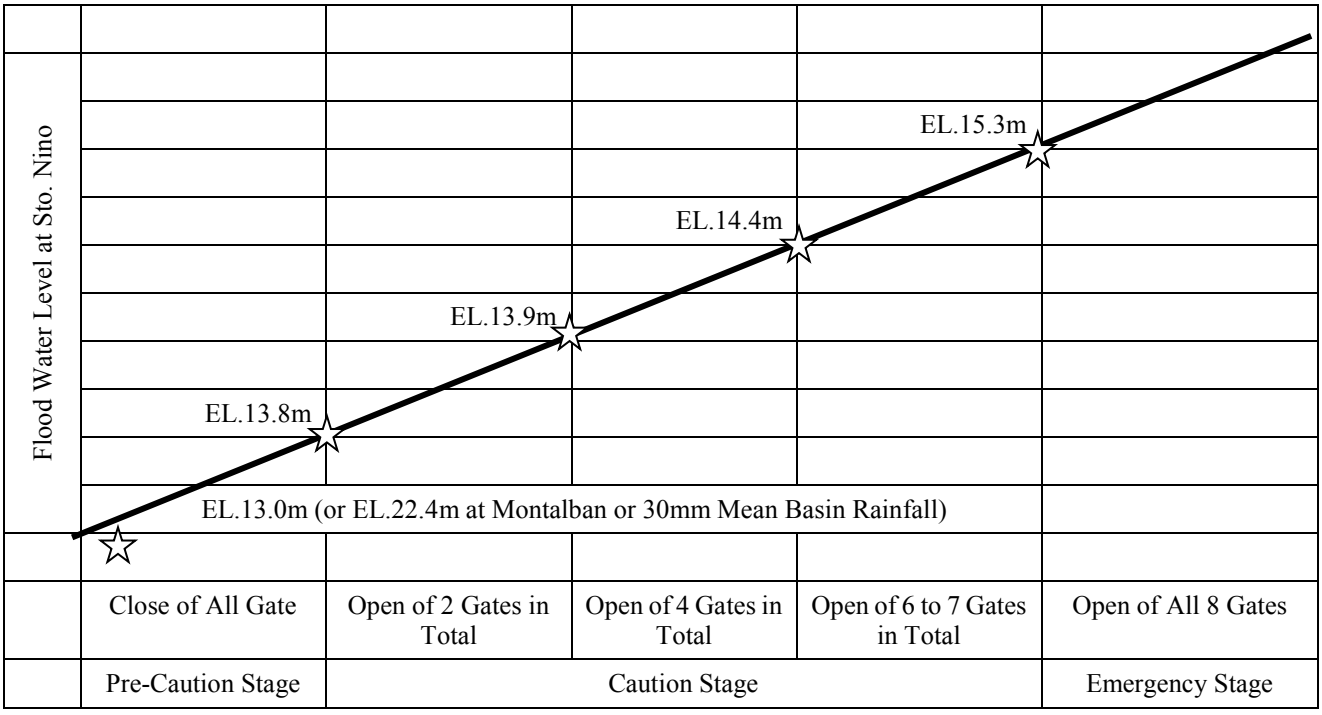
Gate Operational Rule of Rosario Weir

I. OPENING OF ROSARIO WEIR FLOODGATES

WATERLEVEL (M)	NO. OF GATES TO OPEN	GATE NO.	REMARKS
13.80 13.90	1 1	GATE 4 GATE 5	ISSUE WARNING TO ALL WARNING POST STATION
14.00-14.40	4	GATE 3 & 6	
14.50-15.10	6	GATE NO. 2 & 7	
15.30 - UP	8	GATE NO. 1 & 8	ALL GATES SHOULD BE OPEN AND REMAINED OPEN IF CONTINOUS RAINFALL IS BEING MONITORED UPSTREAM

II. CLOSING OF ROSARIO WEIR FLOODGATES

WATERLEVEL (M)	NO. OF GATES CLOSED	GATE NO.	REMARKS
15.00	**2 gates**	GATE 1 & 8	If there will be no rainfall monitored upstream gates should be randomly closed except for the last two gates which will be randomly closed when the elevation at Sto. Niño Station reached at 13.80m waterlevel at Rosario should be closely monitored due abnormalities of the difference in the elevation bet Sto. Niño and Rosario J.S. when waterlevel is at its normal stage.
14.50	**4 gates** add 2 gates	GATE 2 & 7	
14.00	**6 gates** add 2 gates	GATE NO. 3 & 6	
13.80	**7 gates** add 1 gate	GATE NO. 8	
13.60	**ALL GATES SHOULD BE CLOSED**	GATE NO. 1	ALWAYS CHECK watelevel level at Rosario J.S. at the moment it was closed, if overtopping persists at the gate, open 1m height at one of the gates.



Gate Operation Procedure at Rosario Weir for Opening

3.2 Operation Rule of Napindan Hydraulic Control Structure

(1) Project Description

The Napindan HCS is intended to control the lake storage and firm up a dependable discharge and prevent saltwater intrusion from Manila Bay into the lake during low water level of Laguna Lake and high stages of Manila Bay.

The Napindan HCS is operated to maintain the lake within the designed level to serve all purposes. The lake water is intended to serve and at the same time adverse inundation of the surrounding lands.

The Napindan HCS located upstream of the Napindan Channel at the junction of the Pasig-Marikina River-Napindan Channel, is an essential component in the Laguna de Bay Development Scheme for water resources and is aimed to:

- Protect and improve the quality of lake water by cutting off the backflows of saline and polluted water from the Pasig River particularly during high tide in summer when the lake water is lower than that of the tide in Manila Bay.
- Control the lake storage to firm up dependable discharge of water supply for irrigation and other use.
- Prevent the overflow of flood water along the Pasig River in coordination with the Mangahan Floodway, thus protecting Manila and suburbs from floods.

(2) Project Components

The Napindan HCS consists of:

a) Gated Spillway Dams (4 vertical roller type steel gates x 15.0 m wide x 9.0 m high),
b) Navigational Lock (2 submersible radial steel gates x 18.0 m wide x 9.0 m high),
c) Mooring Facilities, and
d) Control Tower at where Napindan HCS Monitor Station is located.

(3) Gate Operation Rule of Napindan HCS

The water level of Laguna Lake reveals that the water level at the Rosario Weir is always higher than that of the Laguna Lake at the flooding of Marikina River.

There is no clear correlation between water levels at the confluence of the Napindan Channel and the Pasig-Marikina River, and the Laguna Lake.

A part of floodwater from the Lower Marikina River into the Napindan Channel/Laguna Lake is not significant.

Thus, all the gates of the Napindan HCS shall be closed to storage temporarily the Marikina River floodwater diverted through Mangahan Floodway into the Laguna Lake, so as not to cause overbank flooding along the Pasig River.

3.3 Operation of Flood Warning along Mangahan Floodway

(1) General

Rosario Weir is usually closed during dry/rainy season. When the opening of gates for diverting flood water into Mangahan Floodway, there is fear that floodwater and surge wave might cause man-made calamity . Therefore, issuance of warning is necessary before opening gates.

Combination of siren/speaker system on Warning Posts and patrol car system is applied for the warning. The remote control system is adopted for prompt issuing of warning. Eight (8) Warning Posts are provided at the interval of 1.0 km (500 m radius) along the Floodway.

(2) Issuance Warning

Warnings shall be issued for the four (4) stages:

	Stage	Warning	Gate Operation	Warning Operation
1	Pre-Caution	Pre-caution	All gate closed	Broadcast recorded voice from Warning Post (WP) No.1 (3 minutes)
2	Caution	Urgent	Start of gate opening after warning	1) Siren warning by all WPs (4 minutes) 2) Broadcast recorded voice by all WPs (3 minute) 3) Gate opening
3	Emergency	Informative	Floodwater level rising	1) Siren warning by all WPs (4 minutes) 2) Broadcast recorded voice by all WPs (3 minutes)
4	Post-flood	Informative	Flow subsiding (Closing gates)	Broadcast recorded voice by all WPs (3 minutes)

3.4 Flood Forecasting

At present, the flood control structures are operated utilizing the actually monitored data such as water levels at Sto. Niño, Montalban and Fort Santiago, and rainfall.

Normally, floodwaters take only 30 minutes to travel between Sto. Niño and the Rosario Weir and 2.5 hours between Montalban and Rosario Weir. A flood forecasting system based on the monitored or forecasted rainfall is therefore essential and effective for the overall flood management in Metro Manila as well as operation of flood control structures.

There might be two ways to utilize the flood forecasting information for the operation, as follows:

- To utilize the forecasted data produced by the existing flood forecasting system in PAGASA through sharing the observed rainfall and water level data; and
- To construct a new system using license-free software, such as the HEC model produced by the US Army Corps of Engineers.

Since the MIKE11 for flood forecasting introduced in the improvement/rehabilitation Project in 2002 is not used at present due to need of license fee. To resolve this issue, mutual discussion shall be made among PAGASA and MMDA-EFCOS Project. On the other hand, the EFCOS staff shall make an effort to utilize the license-free software.

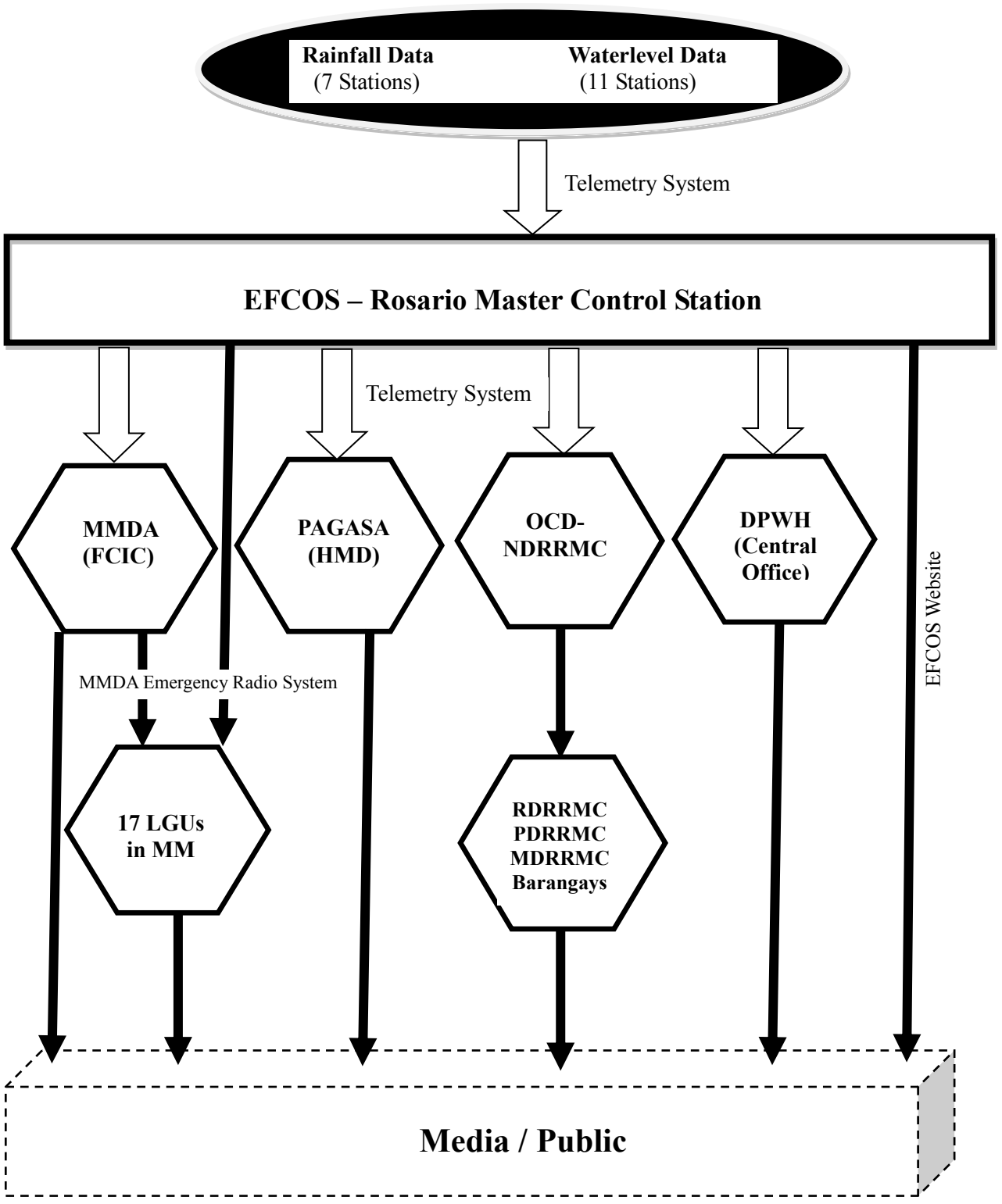
3.5 Transmission and Dissemination of Flood Information

3.5.1 Flood Information Transmitted from MMDA-EFCOS

Flood Information for the Pasig-Marikina River and Laguna de Bay Complex using the telemetry system under the EFCOS Project, is managed and controlled by the MMDA. Currently MMDA is responsible for issuing flood warning information to the concerned government agencies such as OCD-NDRRMC, PDRRMC, and other LGUs.

PAGASA/HMD has no authority to manage and control the system. It receives and monitors information from the MMDA.

The MMDA-EFCOS Rosario Master Control Station is responsible for issuing the flood information. The overall process diagram of Flood Information Network in Pasig-Marikina River and Laguna Lake Complex is shown as below.



Transmission of Rainfall/Waterlevel Data Provided with Telemeters in the Pasig-Marikina River and Laguna Lake Complex

3.5.2 Flood Information for Dissemination

(1) Water Level

Flood situation (Alert, Alarm and Critical Water Level) is set making reference to rating curve approximated by hydraulic calculation and discharge corresponding to a certain water level.

(a) Pasig-Marikina River

Alert Waterlevel is defined as the water level (W.L.) at each gauging station corresponding to the pre-caution stage water level at Sto. Nino (approx. 150 m^3/s and W.L. 13.0m).

Critical Water Level is defined as the water level over which floodwater overtop river dike around area governed by the water level gauging station., thus indicating that the critical water level at each station is corresponding to the water level of the caution stage at Sto Nino Water Level Gauging Station.

(b) Tributary River (San Juan River and Nangka River)

Critical Water Level for the tributaries are decided from the flow capacity (San Juan 50 m^3/s and Nangka 100m^3/s) and rating curve. Alert and Alarm Water Levels are decided with a certain interval from Critical Water Level.

The Alert, Alarm and Critical Water Levels are as listed below:

(Unit: EL. m)

Situation	Pasig-Marikina River					Tributary River	
	Montalban	Sto. Nino	Rosario	Napindan	Pandacan	San Juan	Nangka
Alert	22.4	13.0	12.5	10.9	11.0	11.0	17.1
Alarm	23.0	14.1	13.2	11.9	11.5	11.5	17.7
Critical	23.6	14.9	13.8	12.9	12.0	12.0	18.3

(2) Rainfall

Based on the simulation result by MIKE 11, the relationship between basin mean rainfall intensity (mm/hour) and increase of water level after Pre-caution Stage are as follows:

Status	Rainfall Intensity (mm/hour)	Increase of Waterlevel (m)	
		Montalban	Sto. Nino
Light	10 to 30	0.1 to 0.6	0.1 to 0.6
Light to Moderate	30 to 50	0.6 to 1.2	0.6 to 1.3
Moderate	50 to 70	1.2 to 1.8	1.3 to 2.1
Moderate to Heavy	70 to 90	1.8 to 2.2	2.1 to 2.8
Heavy	90 to 100	2.2 to 2.5	2.8 to 3.1

CHAPTER 4. PLAN OF MAINTENANCE WORKS FOR THE EFCOS PROJECT

4.1 General

All system facilities of EFCOS Project shall be constantly checked, inspected, adjusted, repaired and maintained to meet the objective of the EFCOS Project based on the Maintenance Manual which was prepared in March 2002 in Phase 2.

Other reference manuals for maintenance which are usable for detailed check/inspection of telemetry and equipment facilities are prepared by the Contractor (Japan Radio Co., Ltd.) as follows:

(1) Operation and Maintenance Manual
(2) Instruction Manual or Technical Brochure for Individual Equipment
(3) Instruction manual for measuring instruments is included in the "Instruction Manual" or "Technical Brochures" for individual equipment mentioned above.

4.2 Necessary Maintenance Works

Upon finding the malfunction of the system or equipment, the EFCOS staff shall take necessary actions. Major actions to be taken are summarized as follows:

(1) In case the malfunction occurs at station, the EFCOS staff shall immediately be dispatched to the station site for finding the faulty equipment or unit.
(2) For the telemetry and equipment maintenance work at the site, the EFCOS staff shall bring the Maintenance Manuals and spare parts so as to repair the equipment or unit as quick as possible.
(3) When the EFCOS staff is dispatched to a station site, he shall inspect all the equipment adding to the faulty equipment and shall also check the station civil works.
(4) After typhoon and floods, special inspection shall be performed to check and repair any abnormal condition in and around the station housing.
(5) The equipment room of Rosario Master Control Station is air-conditioned, so that the telemetry master and warning supervisory equipment experienced less failure and still operational up to the present. Based on this experience, Napindan HCS monitor station and Antipolo Relay Station were air-conditioned under the improvement/restoration project in 2016. Attention on maintenance of air-conditions in these stations shall be paid.
(6) Since adequate repair at the site is rather difficult on the telecommunication system, various spare units and spare parts shall be stocked to promptly restore operation of the system by replacing the faulty units at the site.
(7) The necessary stock of spare parts shall be determined and insufficient parts shall be always replenished, based on the list of spare parts prepared under the improvement/restoration project in 2016.
(8) After inspection, adjustment, and repairing, the measured value, trouble conditions, repair contents, etc., shall be recorded in the formatted sheet "Inspection Report of Equipment" to serve as

maintenance reference materials.

(9) If damage or malfunction is too complicated, contact the Contractor's maintenance services "JRC Philippine Branch Office" in Makati City, Metro Manila.

(10) In addition to the maintenance works for stations, the EFCOS Project Office shall have responsibility for maintenance of Rosario Weir, Mangahan Floodway and Napindan HCS.

4.3 Schedule for Maintenance Works

The maintenance work consists of daily maintenance, periodic maintenance and emergency maintenance.

(1) Daily Maintenance Work

The daily maintenance is to be performed mainly from the Rosario MCS by collecting data from individual gauging stations and checking if there is any unavailable gauging station.

(2) Monthly Maintenance Work

The periodical maintenance is to be performed by visiting the stations and checking to find if there is any malfunction of equipment and civil works. The periodical maintenance shall be done monthly.

1) Monthly Maintenance Work including equipment performance test as preventive maintenance and clearing the station sites for design requirements.

2) Monthly Maintenance Work including electrical checking and equipment calibration by using measuring instruments to know degradation/deterioration of equipment to be done before the onset of the rainy season.

The following table shows a yearly maintenance schedule. The daily and periodic maintenance program consists of combination of several maintenance works depending on maintenance period as presented in the following table.

(3) Emergency Maintenance Work

Emergency maintenance work shall be needed in flooding season, especially after typhoon and flood.

Schedule of Maintenance Work

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monthly Maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Emergency Maintenance					✓	✓	✓	✓	✓	✓	✓	

Maintenance Items in Daily and Monthly Maintenance Work

Maintenance Item		Maintenance Works		Remarks
		Daily	Monthly	
1	Operation Check (Overall)	✓	✓	Operation from Rosario MCS
2	Operation Check		✓	Individual Equipment
3	Metering Check		✓	Voltage, Power, Signal
4	Alarm Check	✓	✓	Equipment Alarm
5	Physical Appearance Check		✓	Equipment Physical Damage
6	Performance Check		✓	Electrical Check

7	Equipment Calibration		✓	Power, Frequency, etc.
8	Equipment Clearing		✓	Rainfall Gauge, Water Level Sensor
9	Civil Works		✓	Floor Cleaning, tree/ grass/bush trimming

4.4 Spare Parts Supply

Additional spare parts are supplied in 2016 under the Phase 3 for the EFCOS Project to compensate for the equipment newly installed considering the history of spare parts consumption as analyzed in the Detailed Planning Survey conducted by JICA in 2014 for improvement/restoration of the EFCOS Project.

Record of utilization of spare parts should be strictly made and inventory check should also be done periodically for additional supply.

CHAPTER 5. PLAN FOR ORGANIZATION OF THE EFCOST PROJECT

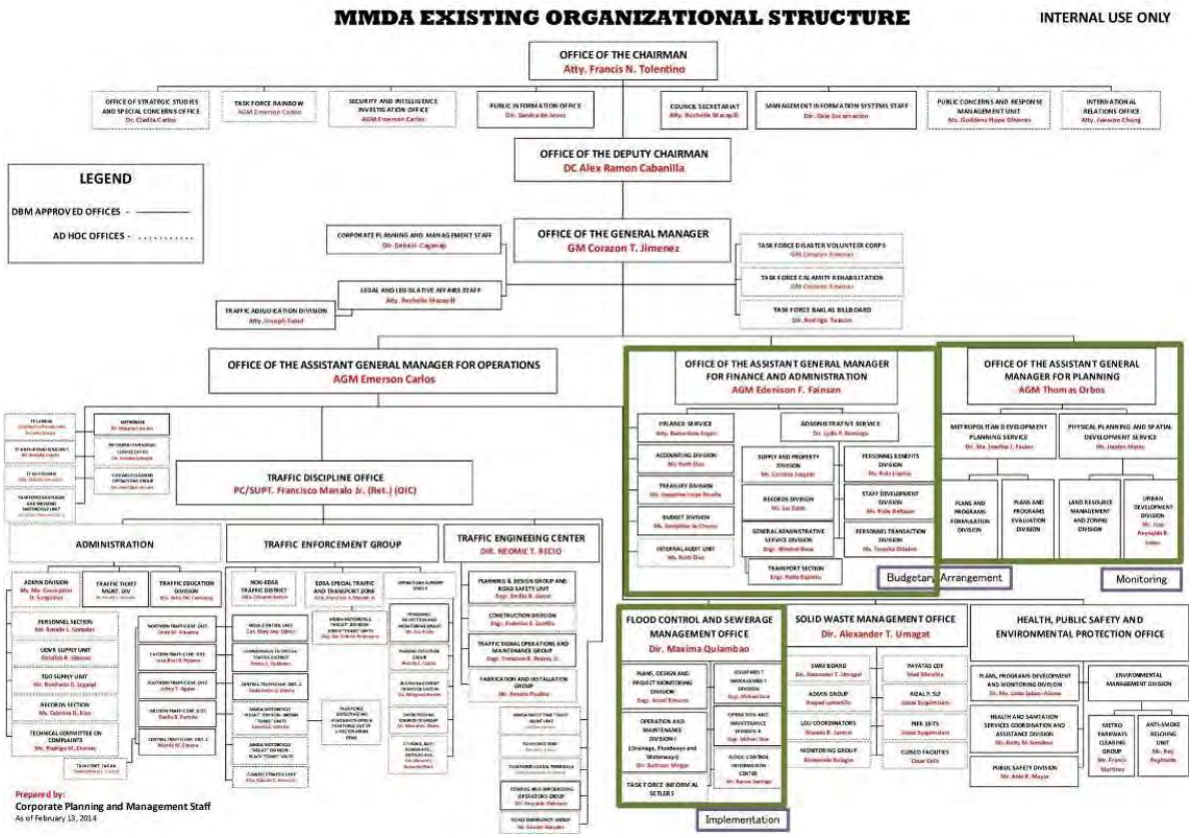
5.1 Organization of MMDA

There are three assistant general management offices in MMDA, namely:

(1) Office of the Assistant General Manager for Planning,
(2) Office of the Assistant General Manager for Finance and Administration, and
(3) Office of the Assistant General Manager for Operations.

Under the Office of the Assistant General Manager for Operations are four offices, namely;

(a) Solid Waste Management Office,
(b) Traffic Discipline Office,
(c) Health, Public Safety and Environmental Protection Office, and
(d) Flood Control and Sewerage Management Office



Organizational Structure of the MMDA

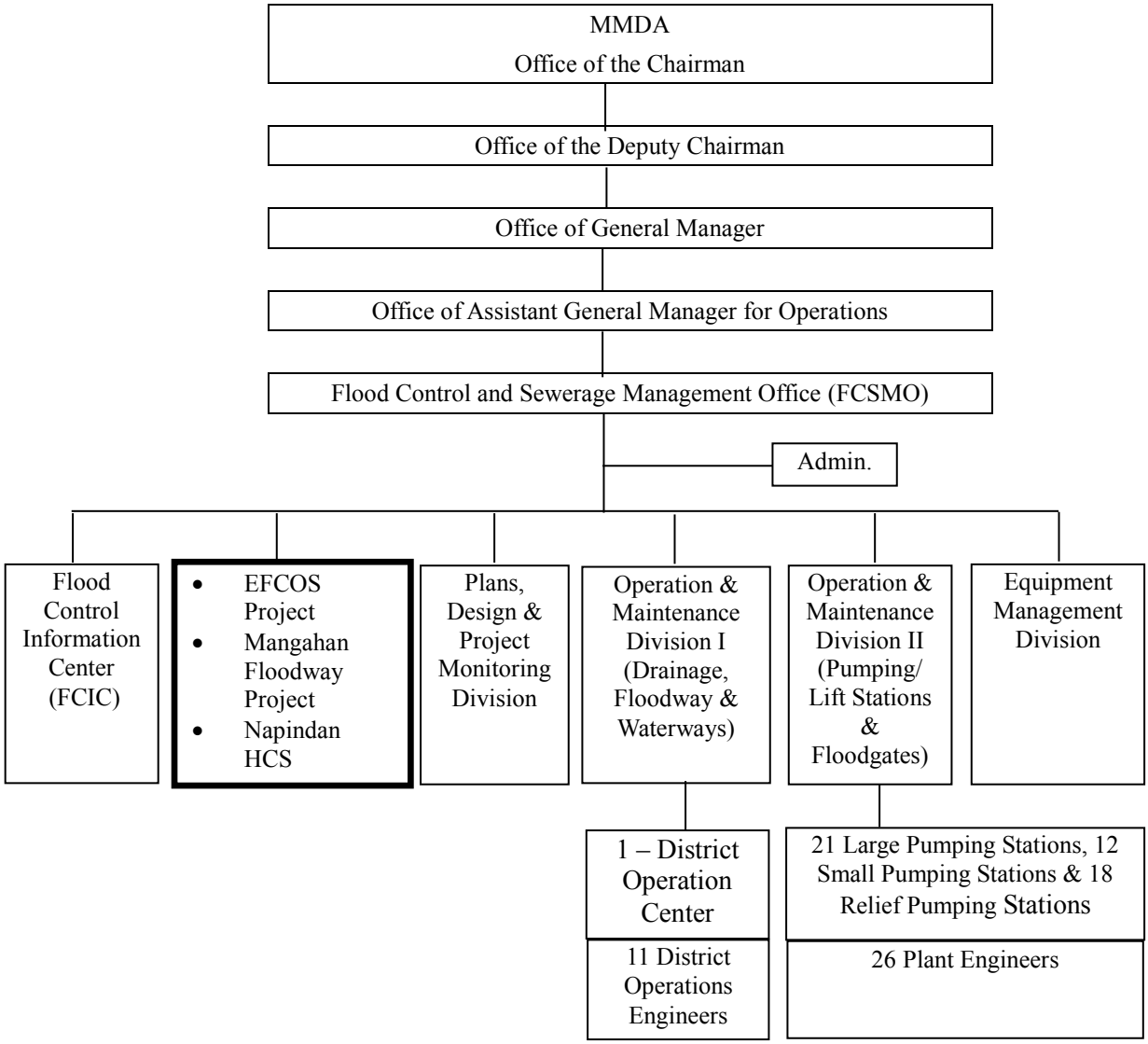
Source: MMDA

5.2 Current Organization of the EFCOS Project

The EFCOS Project, Mangahan Floodway Project (MFP) including Rosario Weir and Napindan Hydraulic Control Structure (NHCS) are under the Flood Control and Sewerage Management Office**.** They are directly under one responsible Director.

Figure below shows the organizational structure of the EFCOS Project as the implementation body of the system.

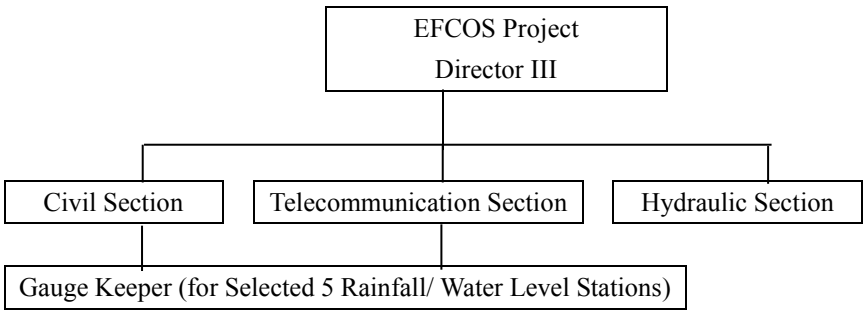
(1) Structural Organization of MMDA-Flood Control and Sewerage Management Office



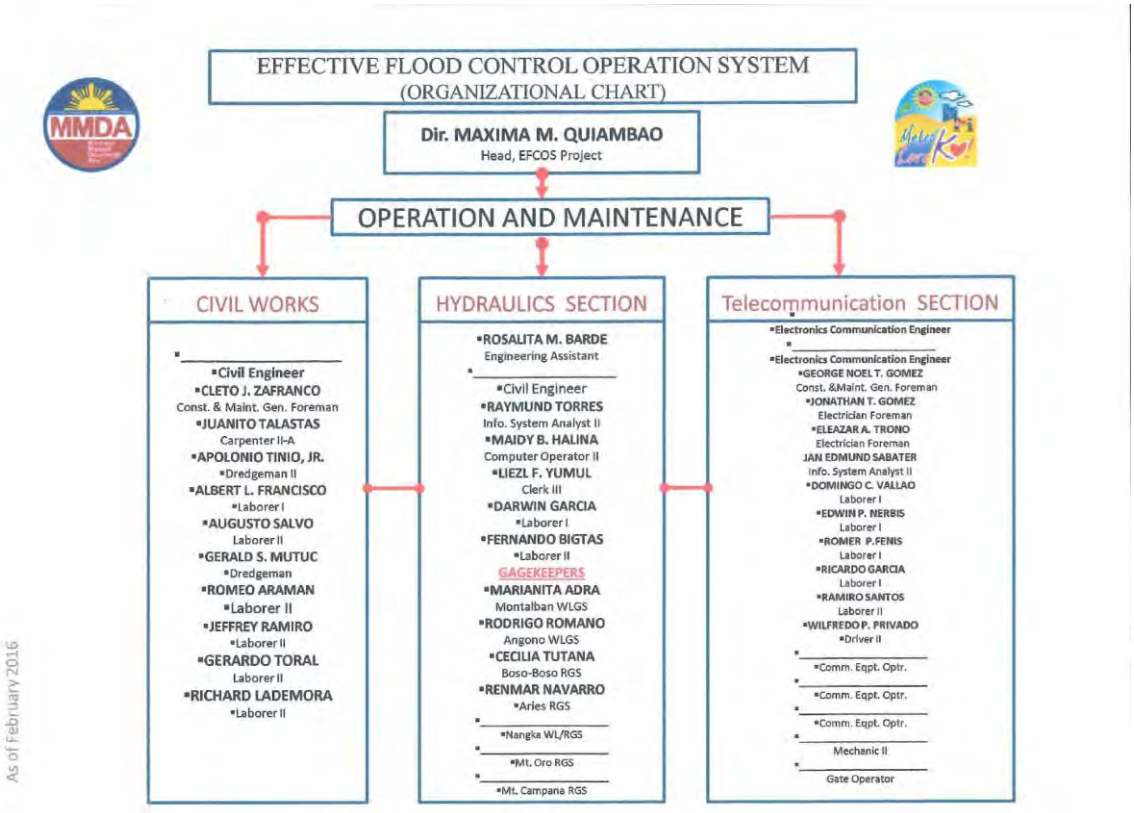
Organizational Structure of the Flood Control and Sewerage Management Office

(2) Organization of the EFCOS Project

The EFCOS Office for operation and maintenance is divided into 3 sections:



Based on the figure above, the below-table summarizes the staffing structure by capacity level in the EFCOS Office as of February 2016. The EFCOS Office consists of total 31 staff, and only one engineering assistant and four foreman are capable for the technical operation and maintenance works among them.



Current Organizational Structure of the EFCOS

(3) Role and Responsibility

Works	Role/Responsibility
1. Civil Works	(1) Gate Operation of Rosario Weir (2) Gate Operation of Napindan HCS (3) Warning operation along Mangahan Floodway (4) Maintenance of civil works of all stations (5) Maintenance of channel at water level stations (clearing, deepening, slope protection, etc.) (6) Preparation of reports (for monthly activity, yearly activity, particular activity, etc.)
2. Hydraulics	(1) Collection and observation of hydrological data and analysis (rainfall, water levels and discharges) (2) Estimation of hydraulic conditions of the Pasig-Marikina River, Mangahan Floodway, Napindan Channel, Nangka River, San Juan River, etc., with the use of available software in relation with the weather forecasting and gate operation during flooding condition (3) Preparation of flood information for flood control and warning operation for EFCOS Website for public, LGUs, and agencies concerned (4) Improvement of data collection through on-line data processing (5) Continuous study on actual hydrological condition for the effective flood control operation system in Pasig-Marikina River and Laguna Lake Complex. (6) Recording of data and reporting of the above-activities (monthly and yearly)
3. Telecommunication	(1) Maintenance of telemetry and warning system (2) Inventory of spare parts of equipment (3) Preparation of reports of the activities above
4. Gauge Keeper (Part-time)	(1) To inform the status of stations periodically (monthly) (2) To inform the emergency on stations as soon as possible. (3) Cleaning/cutting trees at the stations

(4) Manning Schedule in Flood Phase at Rosario Master Control Station

The following is proposed Plan of Structural Organization of EFCOS Project, considering the above-situation. During flooding phase, two (2) staffs of EFCOS Office be assigned at Rosario Master Control Station to monitor the real time data and flood information for 24 hours under three (3) shifts.

During flood phase, EFCOS Project Office need to establish the special manning assignment. All staff perform the task during flood phase, as scheduled below:

	Stage in Flood Phase	Arrangement of Technical Staff to be Assigned
1	Pre-caution	3 shifts
2	Caution	All staff on duty
3	Emergency	All staff on duty
4	Post-flood	3 shifts

5.3 Plan for Structural Organization of the EFCOS Project

(1) Reinforcement of Operation and Maintenance Staff

The EFCOS needs reinforcement of technical staff for operation and maintenance of the telecommunication system. After completion of restoration of the EFCOS in February 2016, there is requirement of new skill for maintenance of newly installed equipment. At least two (2) more technicians with skill and knowledge on telecommunication systems should be required in addition to the current number of staff members of the Telecommunication Section of the EFCOS.

In addition, the Telecommunication Section of EFCOS has recently undertaken the responsibility of maintaining about 40 water level and 4 rainfall gauge stations provided by DOST-ASTI in the entire Metro-Manila. Even under the current situation, EFCOS is short of operation and maintenance staff because there are one assistant engineer and four foremen only. It is apparent that the Telecommunication Section of EFCOS has a shortage of work force to be involved in maintaining EFCOS.

(2) Manning Schedule in Flood Phase at Napindan HCS

Staff stationed at Napindan HCS are to execute the gate open/close per instruction of EFCOS Project Office.

Manning Arrangement for O&M of EFCOS Project

	Designation	Number of Personnel		
		Planned (Total)	Occupied (as of March 2016)	Vacant (as of Feb. 2016)
1	**Director**	1	1	-
		(1)	(1)	(-)
2	**Civil Section**			
1)	Civil Engineer	1	-	1
2)	General Foreman for Construction & Maintenance	1	1	-
3)	Carpenter II-A	1	1	-
4)	Dredgeman I	1	1	-
5)	Dredgeman II	1	1	-
6)	Laborer I	1	1	-
7)	Laborer II	5	5	-
	(Total)	(11)	(10)	(1)
3	**Hydraulics Section**			
1)	Engineering Assistance	1	1	-
2)	Civil Engineer	1	-	1
3)	Information System Analyst II	1	1	-
4)	Computer Operator II	1	1	-
5)	Clerk III	1	1	-
6)	Laborer I	1	1	-
7)	Laborer II	1	1	-
	(Total)	(7)	(6)	(1)

3	**Telecommunication Section**			
1)	Electronics Communication Engineer	2	1	1
2)	General Foreman for Construction & Maintenance	1	1	-
3)	Electric Foreman	2	2	-
4)	Information System Analyst II	1	1	-
5)	Laborer I	4	4	-
6)	Laborer II	1	1	-
7)	Common Equipment Operator	3	-	3
8)	Mechanic II	1	-	1
9)	Gate Operator	1	-	1
10)	Driver II	1	1	-
	(Total)	(17)	(11)	(6)
4	**Gauge Keeper**			
1)	Montalban Water Level	1	1	-
2)	Nangka Rainfall/ Water Level	1	-	1
3)	Angono Water Level	1	1	-
4)	Boso Boso Rainfall	1	1	-
5)	Aries Rainfall	1	1	-
6)	Mt. Oro Rainfall	1	-	1
7)	Mt. Campana Rainfall	1	-	1
	(Total)	(7)	(4)	(3)
	(Grand Total)	(43)	(32)	(11)

CHAPTER 6. PLAN FOR BUDGETARY REQUIREMENT

6.1 General

The EFCOS office is under the Flood Control and Sewerage Management Office, which has the third biggest annual budget in the MMDA.

The O&M cost covers regular maintenance and manufacturer's maintenance cost.

It is assumed that MMDA-EFCOS make and contract with the manufacturer (Japan Radio Corporation Philippines Branch) for maintenance of telemetry equipment. The manufacturer's maintenance is to confirm the EFCOS functions periodically. If defects are found, the manufacturer shall repair them. The manufacturer's cost is only for the dispatch
Of maintenance staff, excluding cost of materials for repair.

6.2 Plan for Yearly Budgetary Requirement

Budgetary requirements for O&M of EFCOS Project are planned from 2016 to 2020 (5-year) in this O&M Plan as shown in the tables below:

Summary of Proposed Annual O&M Budgetary Requirement of EFCOS Project

(Unit: million PHP)

Year	2016	2017	2018	2019	2020
Proposed Budget	14,904,000.00	15,703,000.00	16,574,000.00	17,685,000.00	19,605,000.00
Remarks	Improvement/Restoration works completed in February 2016 and within Contractor's guarantee period.				

(1) Breakdown of Proposed Budget for Year 2016

(Unit: PHP)

I.	**Operating Expenses**	**9,025,000.00**	
	(1) Salary	6,495,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	845,000.00	
	(4) Miscellaneous	100,000.00	
II.	**Civil Works Maintenance**	**3,000,000.00**	
III.	**Maintenance of Telecommunication Equipment**	**2,879,000.00**	
	(1) Manufacturer's Periodical Maintenance	1,836,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	**PHP14,904,000.00**	

(2) Breakdown of Proposed Budget for Year 2017

(Unit: PHP)

I.	**Operating Expenses**	**9,785,000.00**	
	(1) Salary	7,144,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	946,000.00	
	(4) Miscellaneous	110,000.00	
II.	**Civil Works Maintenance**	**3,000,000.00**	
III.	**Maintenance of Telecommunication Equipment**	**2,918,000.00**	
	(1) Manufacturer's Periodical Maintenance	1,875,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	**PHP15,703,000.00**	

(3) Breakdown of Proposed Budget for Year 2018

(Unit: PHP)

I.	**Operating Expenses**	**10,303,362.75**	
	(1) Salary	7,859,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	750,000.00	
	(4) Miscellaneous	110,000.00	
II.	**Civil Works Maintenance**	**3,000,000.00**	
III.	**Maintenance of Telecommunication Equipment**	**3,270,000.00**	
	(1) Manufacturer's Periodical Maintenance	2,227,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	**PHP16,574,000.00**	

(4) Breakdown of Proposed Budget for Year 2019

(Unit: PHP)

I.	**Operating Expenses**	**11,090,000.00**	
	(1) Salary	8,645,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	750,000.00	
	(4) Miscellaneous	110,000.00	
II.	**Civil Works Maintenance**	**3,000,000.00**	
III.	**Maintenance of Telecommunication Equipment**	**3,595,000.00**	
	(1) Manufacturer's Periodical Maintenance	2,552,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	1,000,000.00	
	Total	**PHP17,685,000.00**	

(5) Breakdown of Proposed Budget for Year 2020

(Unit: PHP)

I.	**Operating Expenses**	**11,829,000.00**	
	(1) Salary	9,444,000.00	
	(2) Utility Bills (Water, Electric, Tel., etc.)	1,585,000.00	
	(3) Car Maintenance	750,000.00	
	(4) Miscellaneous	110,000.00	
II.	**Civil Works Maintenance**	**3,000,000.00**	
III.	**Maintenance of Telecommunication Equipment**	**4,876,000.00**	
	(1) Manufacturer's Periodical Maintenance	2,833,000.00	
	(2) Radio Station License Fee	43,000.00	
	(3) Materials	2,000,000.00	
	Total	**PHP19,605,000.00**	

CHAPTER 7. RELATED PROJECTS

7.1 General

In Pasig-Marikina River basin and greater Metro Manila, there are major projects assisted by the international donors regarding the flood control. For the O&M activities of the EFCOS Project, these related projects should be closely monitored and participated.

Although vulnerability to the flooding extends over the territory of the Philippines, Metro Manila has a high risk against flooding. Among the river system in Metro Manila, the Pasig-Marikina River basin has the highest one. The EFCOS Project is categorized into meteorological and hydrological monitoring network and early warning system among the various flood control measures.

The following are other major projects in this field. PAGASA as a leading national agency in meteorological and hydrological monitoring and flood forecasting is the one of the responsible agencies of these major projects.

In the Pasig-Marikina River basin, PAGASA has a responsibility on overall flood forecasting over the entire basin through the KOICA Project (II), while MMDA has a responsibility on the meteo-hydrological monitoring network of EFCOS to manage the flood control structures along the river system. As of date (2016), the donors installed the following networks in the basin.

- Establishment of early warning and monitoring system for disaster mitigation in Metro Manila (KOICA Project (II)) funded by KOICA (Korea International Cooperation Agency);
- Building community resilience and strengthening local capacities for recovery and disaster risk management (Resilience Project), funded by CIDA (Canadian International Development Agency) and UNDP (United Nations Development Plan);
- Nationwide operational assessment of hazards project (Project NOAH), a national project managed by the DOST-ASTI (Advanced Science and Technology Institute); and
- Enhancing Greater Metro Manila's Institutional Capacities for Effective Disaster/Climate Risk Management towards Sustainable Development (GMMA READY Project)

As presented the following summarized project features, each project has been implemented following its different objectives, even though their target basin is the same Pasig-Marikina River basin. KOICA Project (II) has its objective to establish the early flood warning system along the Pasig-Marikina and San Juan River. The objective of Resilience Project is to strengthen community-based disaster risk management, while that of Project NOAH is to construct nation-wide hydrological monitoring network. From those different objectives, the system configuration and their robustness are different.

7.2 KOICA Project (II)

The KOICA Project (II) constructed hydrological monitoring and telemetering system and flood forecasting system in the Pasig-Marikina River basin to establish the early flood warning system, and PAGASA manages the whole system from monitoring of meteo-hydrological parameters to the warning posts installed along the river course. The following is a summary of the Project:

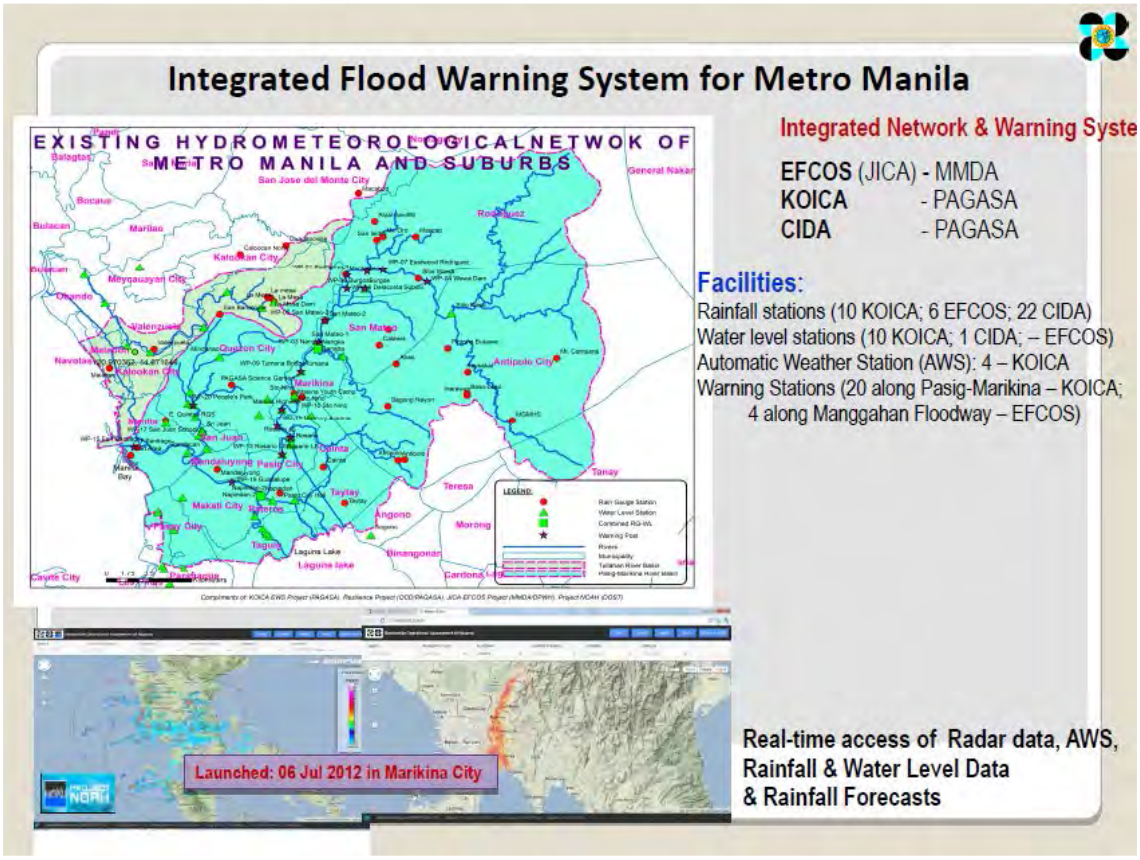
(1) Project Period: Started in November 2010 and completed in May 2012.

(2) Project Objectives: To establish a data collection system, flood forecasting system, early warning system, and radio communication network.

(3) Monitoring and Warning Stations Installed: summarized as table below and shown in location map.

(4) Telecommunication Media: VHF network with 150MHz band, and GSM backup network.

	Station	Name	Location
1	Water Level Gauge Stations (10)	1. San Mateo-1	San Mateo Bridge
		2. Burgos	
		3. Tumana Bridge	
		4. Sto. Nino	
		5. Marcos Highway	
		6. Rosario LS (Lake Side)	
		7. Rosario JS (Junction Side)	Rosario Bridge
		8. Napindan LS	
		9. Napindan JS	
		10. Mindanao	San Juan River
2	Rainfall Gauge Stations (10)	1. San Mateo-2	San Mateo Bridge
		2. Napindan-2	
		3. Guadanoville	
		4. NAIA	
		5. Marikina Youth Camp	Near Marikina Bridge
		6. Cainta City Hall	
		7. Pasig City Hall	
		8. Port Area Synop	
		9. Antipolo	
		10. La Mesa Dam	
3	Warning Posts (20)	Along the Pasig-Marikina River and San Juan River	
4	Relay Stations (3)	1. PAGASA S.G.	
		2. Mt. St. Cruz	
		3. Mt. Mataba	
5	Automatic Weather Stations (AWS) (4)	1. Antipolo	
		2. La Mesa Dam	
		3. Pasig City Hall	
		4. Port Area Synop	



7.3 The Resilience Project

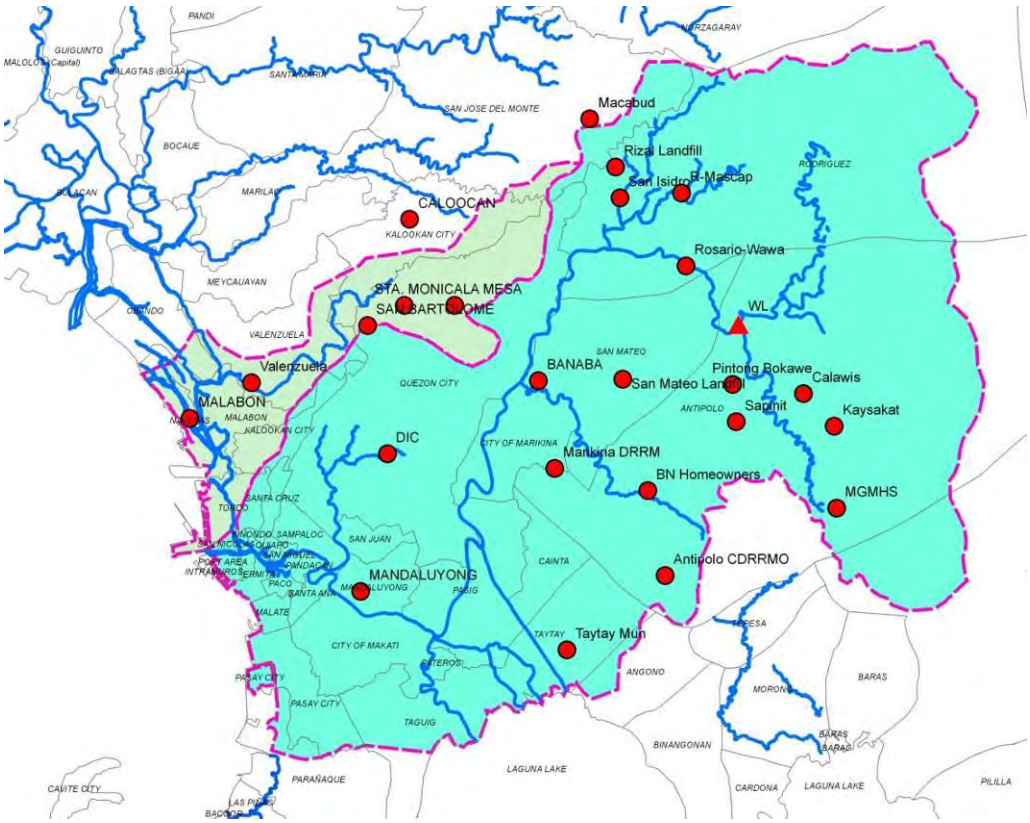
The Project was funded by CIDA (Canadian International Development Agency) and UNDP (United Nations Development Plan), and its objective is to strengthen LGU capacities in disaster risk reduction and management towards building community resilience to disasters and reducing vulnerability to natural hazards. The target area of the Project is Metro Manila. The following is a summary of the Project:

(1) Project Period: Started in 2010 and completed in 2013.

(2) Project Objectives: To establish a flood early warning system in the Pasig-Marikina River and Tullahan River basins; to integrate EFCOS, KOICA, NOAH, and the system installed by the Project; and to support strategic roles of LGUs (Marikina-Pasig-Cainta) in creating disaster risk management sensitive policies and plans ensuring people's participation, accountability and partnership with various stakeholders.

(3) Monitoring and Warning Stations installed: 22 rainfall gauging stations and 1 water level station as shown in location map below).

(4) Telecommunication media: GSM network.



7.4 Project NOAH

The Project NOAH is the DOST's response to the call of the President for a more accurate, integrated, and responsive disaster prevention and mitigation system, especially in high-risk areas throughout the Philippines. The Project is harnessing technologies and management services by the DOST through PAGASA, PHIVOLCS, and the DOST-Advanced Science and Technology Institute (ASTI), in partnership with the UP National Institute of Geological Sciences and the UP College of Engineering.

Originally, the Project NOAH has eight (8) components. Among them, the following three (3) components are closely related to the EFCOS, but these are nationwide target projects. Others have different targets of natural disasters, such as landslides, coastal hazards and storm surge, and different devises development, such as Doppler radar and landslide sensor. These projects progressed targeting the date of December 2013, and the projects enter the operational stages at present.

(1) Distribution of hydro-meteorological devices in hard-hit areas in the Philippines (Hydromet): a total of 600 automated rain gauges and 400 water level monitoring stations were installed along the 18 major river basins by December 2013 to provide a better picture of the country's surface water in relation to flooding.

(2) Disaster risk exposure assessment for mitigation – Light detection and ranging (DREAM-LiDR) project: the project, which was targeted to complete by December 2013, aims to produce more accurate flood inundation and hazard maps in 3D for the country's flood-prone and major river systems and watersheds.

(3) Flood information network (FloodNet) project: targeted to be completed by December 2013 is a flood center that will provide timely and accurate information for flood early warning systems. The FloodNet Project will come up with computer models for the critical river basins; automate the process of data gathering, modeling and information output, and release flood forecasts.

The EFCOS Project Office has responsibility to maintain 3 rainfall gauging stations and 38 water level stations installed by DOST-ASTI in Metro Manila (Pasig-Marikina River, San Juan River and Tullahan River basin).

7.5 GMMA Ready Project

The Project Enhancing Greater Metro Manila's Institutional Capacities for Effective Disaster/Climate Risk Management towards Sustainable Development (herein referred as the GMMA READY Project) aims to decrease the vulnerability of the Greater Metro Manila Area (GMMA) to natural hazards and increase its resilience, by strengthening the institutional capacities of the local government units, concerned national government agencies, academic institutions and civil society organizations to manage disaster and climate change risks. It will attempt to achieve this outcome by:

(1) Assessing the GMMA's vulnerabilities to disaster and climate change risks;
(2) Developing and implementing priority disaster/climate risk mitigation actions for GMMA such as formulation and testing of an integrated contingency plan and establishment of early warning systems;
(3) Enhancing the competencies of GMMA LGUs and critical partners to mainstream DRM/CRM into local planning and regulatory processes;
(4) Demonstrating the mainstreaming of DRM/CRM into local land use/development plan(s) and regulatory processes of Metro Manila and selected GMMA LGUs; and
(5) Establishing a knowledge management system, including a vigorous Community of Practice, on Disaster/Climate Risk Management. The project is envisioned to achieve all the results over a period of three (3) years and expected to improve mechanisms and protocols on DRM/CRM. The project covers Metro Manila and the provinces of Rizal and Bulacan.

The READY Project is a multi-hazard mapping and assessment project undertaken by the NDRRMC and donor partner of AusAID, in partnership with key CSCAND (Collective Strengthening of Community Awareness for Natural Disasters) agencies such as PHIVOLCS, PAGASA, MGB, NAMRIA and other concerned agencies including MMDA. It is built on existing structures and provides the environment for stakeholders to work together with clear roles and responsibilities to perform.

The Project focuses on high-risk areas which were selected based on population size and the number of hazards to which they are vulnerable. It marks the first attempt to approach disasters in a multi-hazard fashion. The goal of strengthening the capacity of key stakeholders sits well in terms of creating an enabling environment in the communities.

The Project encompasses the Disaster Risk Reduction and Management (DRRM) process, to include community-based early warning system and information, education, and communications (IEC) activities. The data and information generated from the Study are utilized by the sectoral agencies and Local Government Units (LGUs) for disaster risk management and planning.

The following is a summary of the Project:

- Target Area/River Basin: Laguna, Rizal, Cavite, and Bulacan Provinces
- Project Period: 2010-2014
- Objectives/Salient Features
    1) Decrease the vulnerability of the Greater Metro Manila Area to natural hazards and increase its resilience, by strengthening the institutional capacities of the local government units, concerned national government agencies, academic institutions, and civil society organizations to manage disaster and climate change risks
    2) CBFEWS (Community - Based Flood Early Warning System) component: install automatic rainfall and water level gauges with wireless capability, intelligence and stand alone operation,

independent power supply from solar and back-up batteries; establish Data Operation Station at the respective PDRRMOs and at PAGASA WFFC that will receive the data, store them in a database, and display real-time information from all the remote stations

CHAPTER 8. FUTURE DEVELOPMENTS IN THE PASIG-MARIKINA RIVER AND LAGUNA LAKE COMPLEX RELATED TO THE EFCOS PROJECT

Among several studied on the EFCOS Project made in the past, the following are to be considered on future development of the EFCOS Project.

8.1 Perspective for Future Expansion of EFCOS to Laguna Lake Basin

The following is recommendation in the Phase 2 (Project for Rehabilitation and Warning System in Metro Manila under the Japanese Grant Aid in 2001).

(1) Telemetry Rainfall Gauge Station

Experts concerned have been saying that rainstorms in Metro Manila generally come from the northwest since most typhoons approach Luzon in that direction. If so, rainfall in the Laguna Lake basin, which is located southeast of Metro Manila, could be an indicator of a coming rainstorm. It means that rainfall forecast for Metro Manila could be possible by installing a telemetry system in rainfall gauging stations in the Laguna Lake basin. At present, however, available rainfall data are still too scarce to examine this hypothesis.

The Laguna Lake had no rainfall gauge in its catchment area for a long time. For the first time in November 1998, LLDA installed five (5) rainfall gauging stations in this area. The purpose of these stations is to study water balance in the lake. Since the rainfall gauges are all automatic recording systems and not telemeterized systems, they are not used directly for flood forecasting purposes. After a few years' observation, however, the accumulated rainfall data could be used for the study on movement of rainfall areas and may provide ideas to determine the necessity of telemetry rainfall stations. Hence, this issue needs to be discussed further after a few years.

(2) Telemetry Water Level Station

One of the typhoon-induced problems along the lakeside areas is **seiche**, which is a sudden fluctuation of water level caused by storing winds and/or low atmospheric pressure. In November 1995, the worst seiche took place in the lake during Typhoon Rosing. Fluctuation of the lake water level and the track of Typhoon Rosing from November 2 to 4, 1995. At Angono the lake water began to be forced back into the lake by strong winds and low atmospheric pressure around 3:00 a.m. on the 3rd of November. The water level which was 12.6 m at 0:00 a.m. went down to the minimum level, 10.8 m at 11:00 a.m. Then, the lake water began to return towards Angono, and rose to reach 13.5 m at 3:00 p.m. The fluctuation range on this day was as large as 2.7 m.

According to EFCOS officials, the sudden water level rise had caused severe damage to lakeside areas in the Laguna and Rizal provinces. However, water level data have been so scarce that fluctuation of water level in the lake could not be generally identified.

A seiche like the one in 1995 would possibly occur again. However, the existing Angono telemetry water level gauge cannot cover all the 900 km^2 lake surface area, and it is very difficult to monitor such a seiche by only one telemetry gauging station. Even in Lake Biwa in Japan with a water surface area of 670 km^2, which is slightly smaller than that of the Laguna Lake, there are six (6) telemetry water level gauges. It is recommended that the telemetry system for water level gauges in the Laguna Lake be augmented in the future.

8.2 Recommendation in the Report on Data Collection Survey on Situation of Nationwide Flood Forecasting and Warning System Conducted by JICA for PAGASA (September 2013)

It should be noted that several monitoring systems already have been established in the Pasig-Marikina River and Laguna Lake basin such as EFCOS, KOICA and NOAH. Further, other initiatives of the UNDP/AusAID (Ready for GMMA) and the UNDP/CIDA (Resilience Project) also include components of flood early warning system in the basin. PAGASA is currently integrating all initiatives under KOICA, CIDA, AusAID, and EFCOS to issue flood information for all stakeholders. PAGASA envisages monitoring of all hydrometeorological data in the GMMA to be shared with LGUs. Under such circumstances, in particular, the following development needs should be taken into consideration:

Future Development Needs

	Job Category	Future Development Needs
1	Basin/River System Monitoring	• Density of monitoring stations increased drastically by NOAH. Classification of existing gauging stations might be required for appropriate maintenance. • Effective use of synoptic and NOAH's monitoring stations with development of management rules of monitoring stations.
2	Data Collection for Flood Forecasting	• Effective system for data processing, transferring and transposing to flood information will be necessary.
3	Database Management	• Integration of several database systems of KOICA, EFCOS, NOAH, UNDP/AusAID (Resilience Project) is crucial. • Skill for updating of the database contents. • Data transferring system to concerned agencies.
4	Discharge Measurement	• Periodical review an update of H-Q Curves.
5	Assessment and Update of Flood Warning Water Levels	• Uniform definitions of warning water levels shall be applied. Substantial review and update of water levels based on the recent occurrence of floods is essential at key monitoring stations.
6	Flood Forecasting	• Flood runoff model has been developed by UP under the Project NOAH. PAGASA will need to judge whether it is usable for flood forecasting proposes or not. • Expansion/updating of existing flood runoff models. • Development of IFAS (Integrated Flood Analysis System). • Development of inundation analysis model.
7	Issuance of Flood Information	• Clear demarcation of responsibility between MMDA and PAGASA for issuance of flood information and warning shall be examined and fixed. • Flood information issued by MMDA or PAGASA shall be examined together with development of the integrated data. • Data/information sharing system among agencies shall be re-established. • Development of more reliable means for rapid transmission of flood information. • Operation manual for utilization of EFCOS and KOICA is necessary.
8	Post-flood Investigation	Conduct of survey without exception will be encouraged.
9	Public Information and Education Drive	• Coordination with PAGASA-HMD, OCD, MMDA and LGUs shall be strengthened. • Experiences in the resilience Project shall be repeated with LGUs.
10	Telemetry and Telecommunication	• Integration of NOAH's stations under PAGASA-HMD with shifting ASTI's function including human resources to PAGASA (if required).

11	Flood Drills	• Under the Resilience Project, flood drills were conducted involving LGUs integrating with issuance of flood information. • To repeat and encourage to conduct the drills.

8.3 O&M of Proposed Marikina Control Gate Structure (MCGS)

A control structure of the Marikina Control Gate Structure (MCGS) in the Marikina River between Rosario Bridge and Rosario Weir is proposed to ensure the flood diversion capacity towards the Mangahan Floodway under the Pasig-Marikina River Channel Improvement Project. Harmonious and effective operation of the three structures, as well as a retarding basin in the upstream areas and Marikina dam development, is one of the emerging issues in the flood control of Pasig-Marikina River. In future, the EFCOS Project will manage the operation and maintenance of MCGS as well as Rosario Weir and Napindan HCS.

8.4 World Bank Report for Master Plan for Flood Management

The government, with the technical and financial support of the World Bank, has prepared a Master Plan for Flood Management in Metro Manila and Surrounding Areas in 2012. The plan, approved by the National Economic and Development Authority (NEDA) Board on September 4, 2012, determines a set of priority structural and non-structural measures to provide sustainable flood management up to a certain safety level. The total estimated cost for the implementation of the Master Plan is about PhP352 billion (about US$8 billion) over a 20-25 year period. The main elements of the Master Plan are:

(1) Structural measures to reduce flooding from river systems that run through the city;
(2) Structural measures to eliminate long-term flooding in the flood plain of Laguna de Bay;
(3) Structural measures to improve urban drainage;
(4) Non-structural measures such as flood forecasting and early warning systems and community-based flood risk management;
(5) Improved institutional structure to deal with flood management in an integrated manner.

The above (4) recommended the early implementation of the following prioritized projects:

(1) Improvement of monitoring and telecommunication equipment of EFCOS, and

(2) Extension of coverage of monitoring and telecommunication system to the Laguna Lake basin and the Malabon-Tullahan River basin for PAGASA.

The details are not described in the report and those are enumerated in the recommendations.

THE PROJECT FOR IMPROVEMENT/RESTORATION OF TELEMETRY EQUIPMENT OF EFFECTIVE FLOOD CONTROL OPERATION SYSTEM (EFCOS PROJECT)

"Promote a Flood Resilient Metropolis"

WELCOME GUESTS AND PARTICIPANTS!!!

SEMINAR
ON

"OPERATION AND MAINTENANCE OF FLOOD FORECASTING AND WARNING SYSTEM IN METRO MANILA"

Date :February 18, 2016
Time : 1:00 – 5:00 PM
Venue : Manila City Room

EFCOS PROJECT

The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

OUTLINE OF PRESENTATION

I. EFCOS Project

- Purpose
- EFCOS Project Area
- How EFCOS Project works..

II. Phase 1

- Gauging Stations
- Warning Posts
- Warning System
- Relay and Monitoring Stations
- Phase 1 Configuration

III. Phase 2

- Gauging Stations
- Phase 2 Configuration
- Typhoon “Ondoy”
- History of Damaged Equipment
- Status of EFCOS before Rehabilitation

IV. Phase 3

- Work Responsibilities of MMDA
- Phase 3 Configuration

V. EFCOS Components

VI. Flood Forecasting and Gate Operation

PURPOSE:

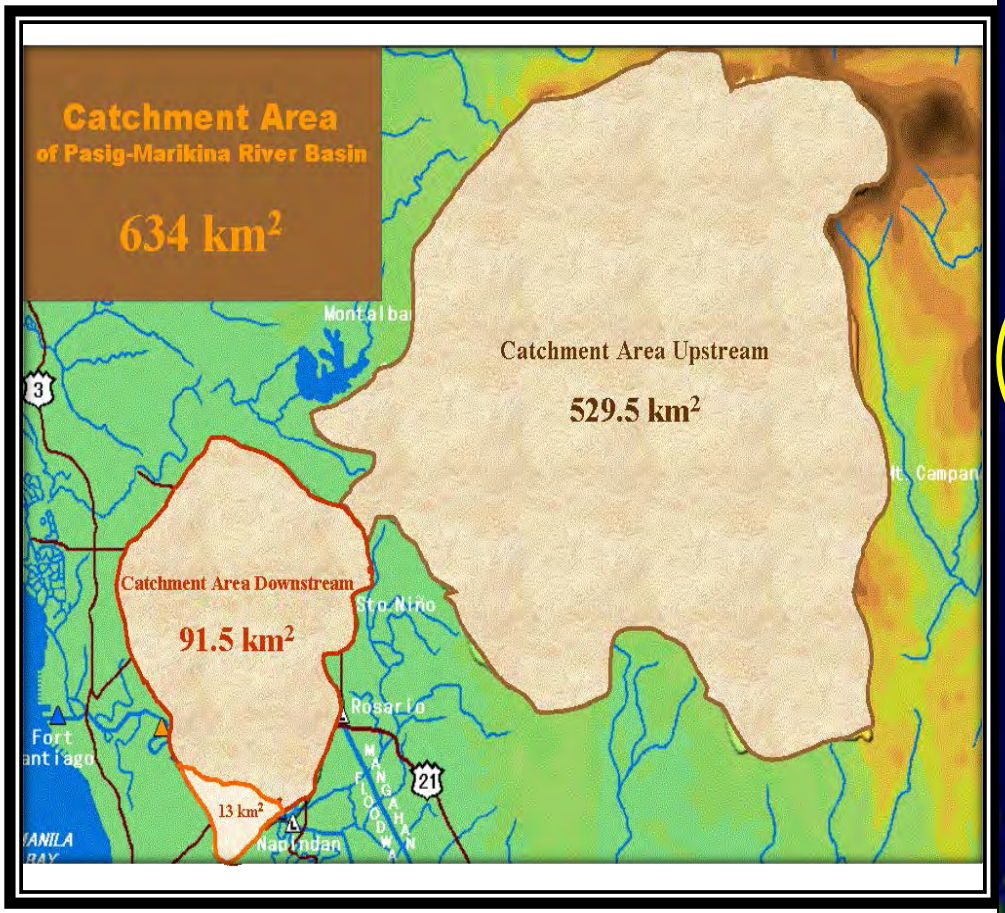
- Designed to address perennial flooding in Metro Manila

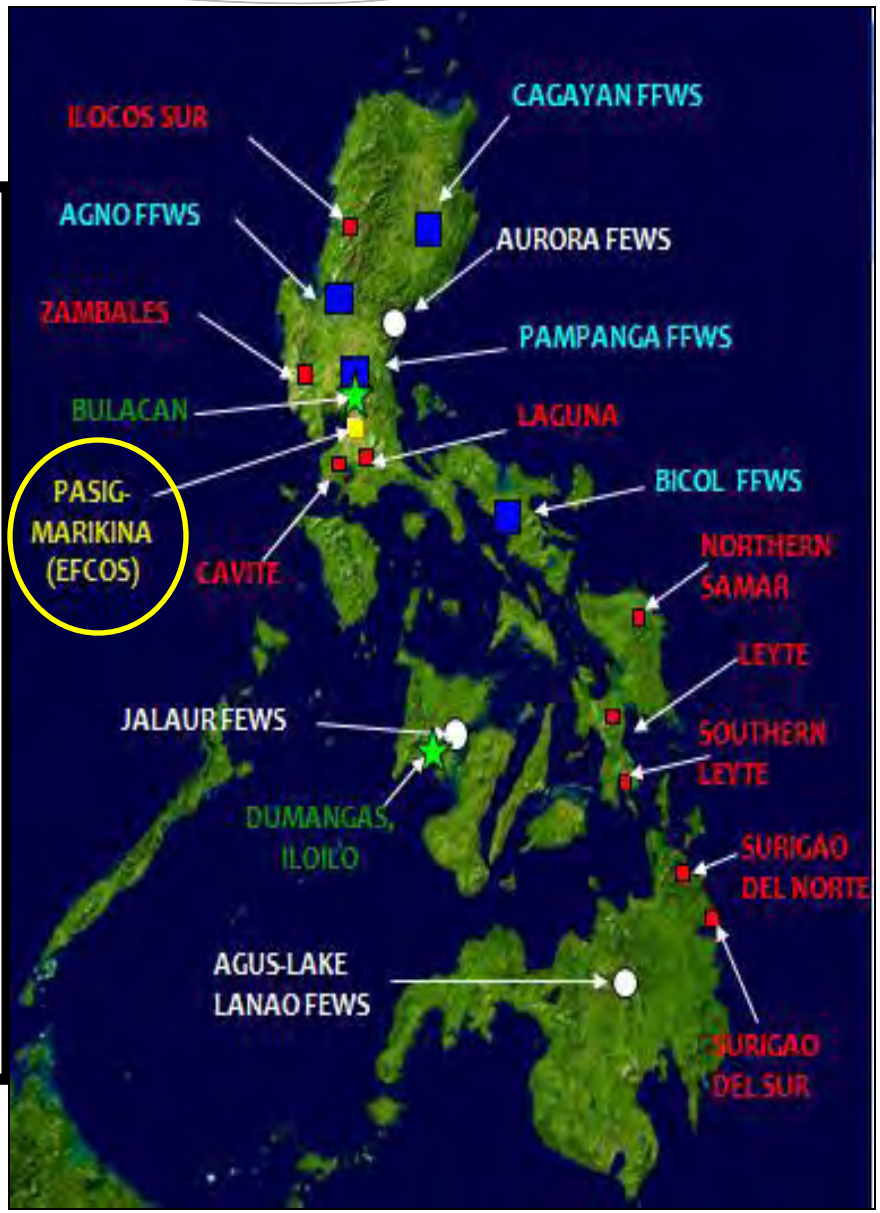
- EFCOS Project is aimed principally for the effective operation of the two flood control structures

- Diverts excess water flowing from Marikina River into Laguna Lake temporarily
- Designed to limit the flood down into the Lower Marikina River and Pasig River to bank full capacity
- Also allows reverse flow from the lake to the Lower Marikina River

- Prevents the backflow of saline and polluted water from the Pasig River
- Constructed to improve the quality of water in Laguna Lake

EFCOS PROJECT AREA:





The Project for the Improvement/Restoration of Effective Flood Control Operation System (EFCOS Project)

HOW EFCOS PROJECT WORKS....

RAIN

ACCURATE HYDROLOGICAL DATA COLLECTION

-UNIFORM DISTRIBUTION OF HYDROLOGICAL GAUGING STATIONS (RAINFALL & WATERLEVEL)
- MORE FREQUENT OBSERVATION
-DATA COLLECTION WITHOUT OMMISSION

DATA TRANSFERRED TO RMCS

AUTOMATICALLY PROCESSED AND VISUALIZED

DATA PROVIDED TO PUMPING STATION AND RELATED AGENCIES

PRECISION & SWIFTNESS OF FLOOD CONTROL FACILITIES OPERATION SHARING OF FLOOD INFORMATION BETWEEN RELATED AGENCIES

DECISION IN ISSUING THE FLOOD WARNING WITHIN THE BASIN. GATE OPERATION WILL COMMENCED

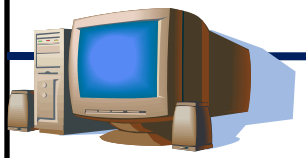
RESULTING TO MINIMIZATION OF FLOOD DAMAGE

TELEMETRY SYSTEM

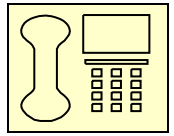
DATA PROCESSING SYSTEM

EMERGENCY RADIO COMMUNICATION

MULTIPLEX RADIO SYSTEM



TELEPHONE SYSTEM



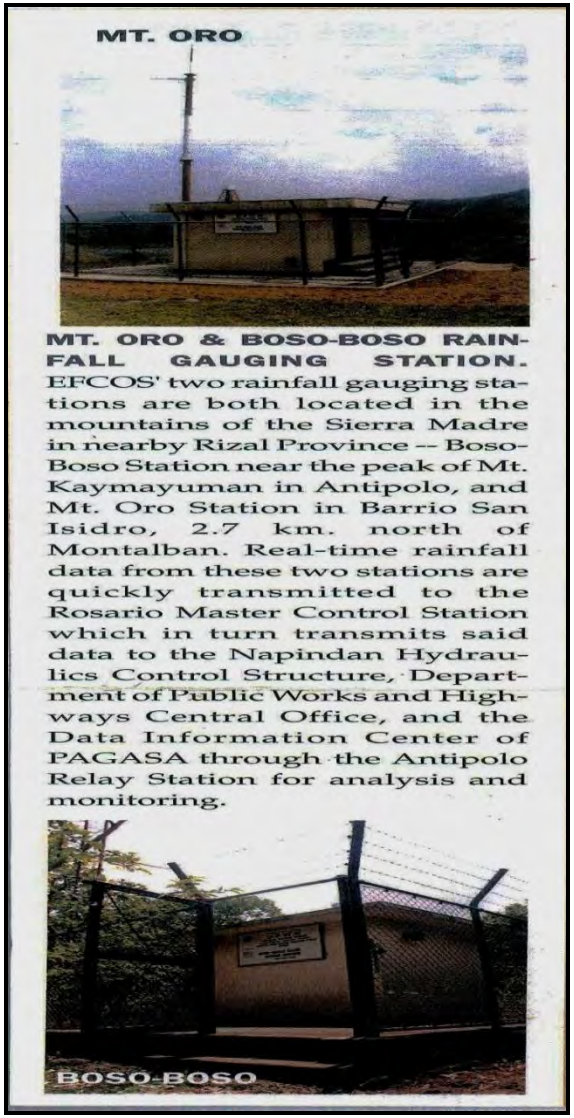
PHASE 1: 1993

- EFCOS system was designed in 1985 as an analogue telemetry system
- It is under Overseas Economic Cooperation Fund (OECF) loan package
- The project cost is 234M PhP
- Inadequate for the Pasig-Marikina River Basin
- Unable to function as a flood forecasting system
- Rehabilitation project was formulated to enhance the overall function of the EFCOS system

Rainfall Gauging Stations

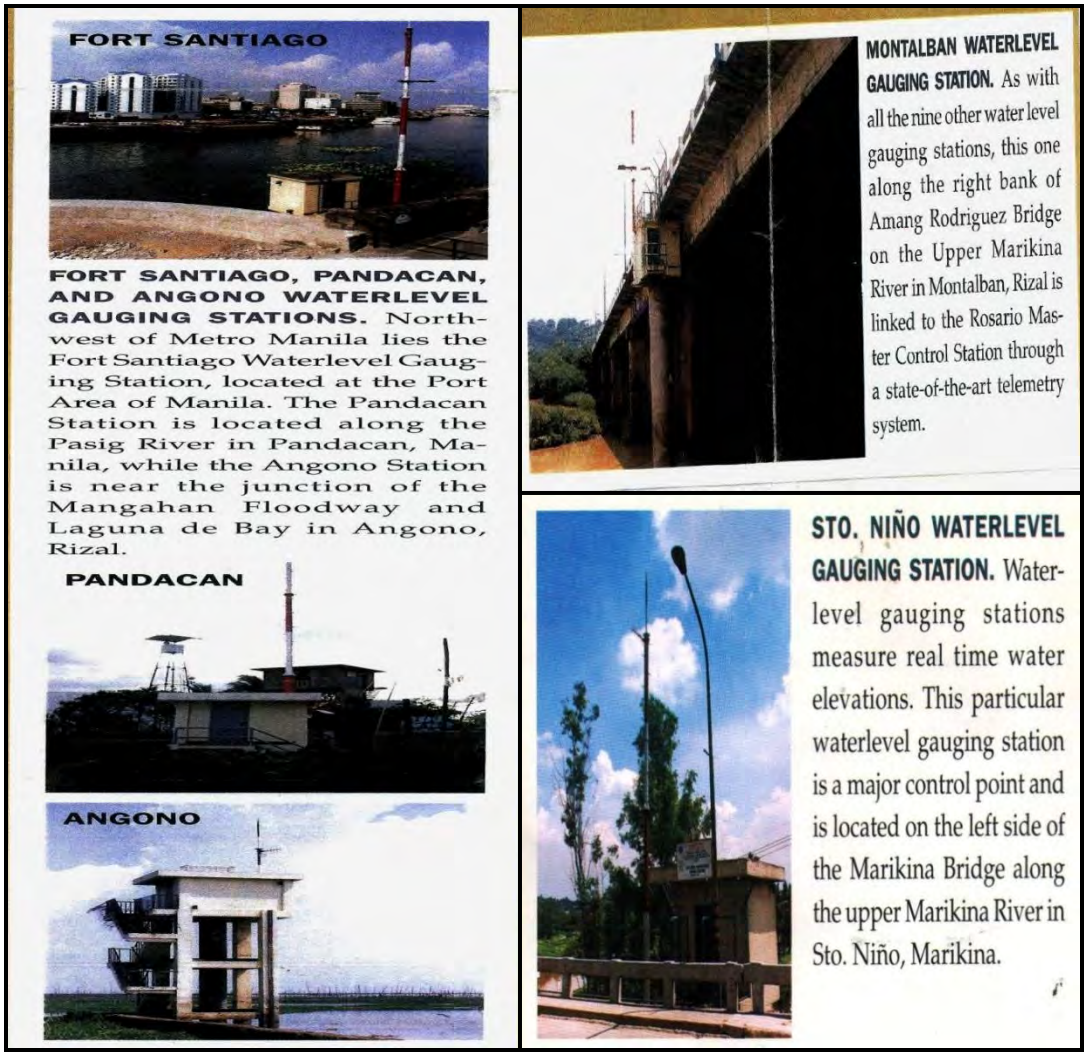
1. Mt. Oro

2. Boso-Boso



Water Level Gauging Stations

1. Montalban
2. Sto. Niño
3. Rosario Lake Side
4. Rosario Junction Side
5. Angono
6. Napindan Lake Side
7. Napindan Junction Side
8. Pandacan
9. Fort Santiago



Warning Post

WARNING POST. Pictured here are two of the nine structures positioned on both sides of the Manggahan Floodway. These warning posts alert people along the floodway that the floodgates are to be opened and that they must evacuate the immediate area to prevent loss in lives and damage to properties caused by floodwaters diverted from the Pasig-Marikina River. Warning post 1 is located inside the Rosario Master Control Station, while the remaining eight are scattered on the east and west main dikes of the Manggahan Floodway Channel. These warning posts are connected to the Rosario Master Control Station through cable and simplex radio.

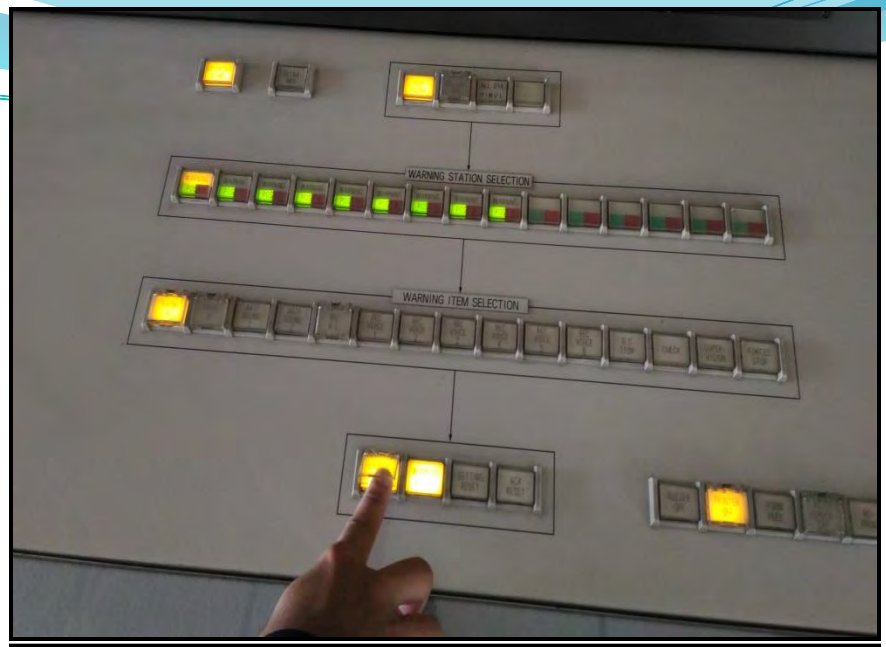
WARNING SYSTEM

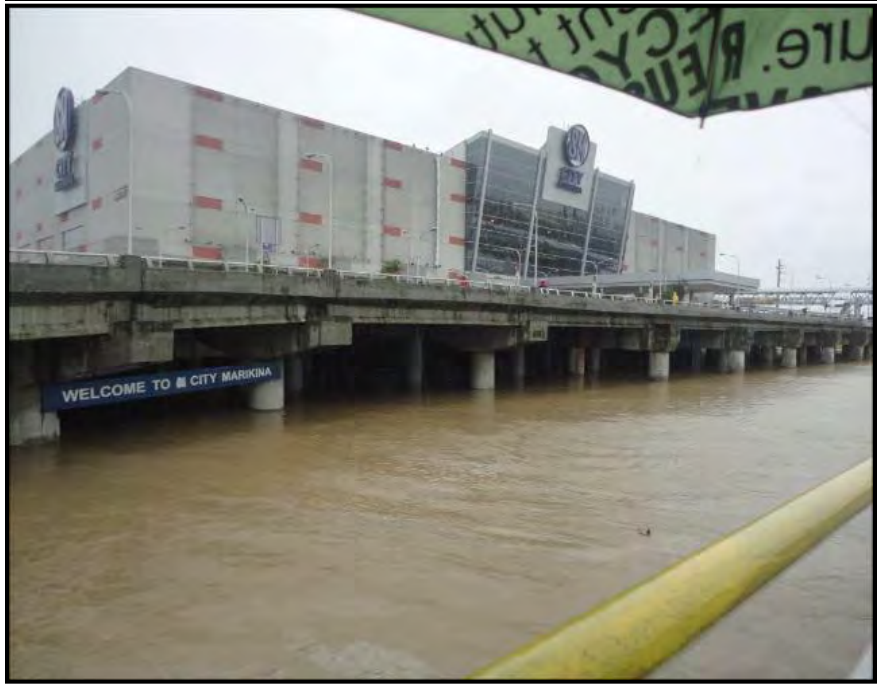
LEVEL 1
PRECAUTION STAGE - ALL GATES ARE USUALLY CLOSE. DURING THIS STAGE ANNOUNCEMENT NO. 1 IS BROADCAST AND REPEATED.

LEVEL 2
CAUTION STAGE - A WARNING CONSISTING OF SIREN, SPEAKER WARNING AND VOICE BROADCAST “NO.2” I ISSUED WITHIN THIRTY MINUTES AFTER THE OBSERVATION OF THE CRITICAL WATERLEVEL AT STO. NINO WLGS.

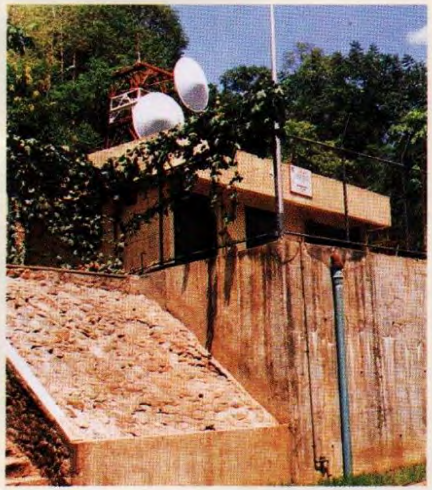
LEVEL 3
EMERGENCY STAGE - THE FLOODWAY IS EXPECTED TO RISE DUE TO LARGE VOLUME OF WATER COMING FROM UPSTREAM OF MARIKINA RIVER . A WARNING CONSISTING OF SIREN SPEAKER WARNING AND VOICE BROADCAST “ NO.3” IS SENT BASED ON THE JUDGEMENT OF THE HYDROLOGIST IN ROSARIO MASTER CONTROL STATION.

LEVEL 4
POST FLOOD STAGE - DURING THIS STAGE, THE WATER IN THE FLOODWAY IS DECREASING BUT A CAUTION IS GIVEN TO THE PEOPLE BECAUSE OF THE POSSIBLE OCCURRENCE OF FLOOD. “VOICE BROADCAST NO. 4 IS SENT AND REPEATED.





Relay and Monitoring Stations



ANTIPOLO RELAY STATION. An important EFCOS communication facility, the Antipolo Relay Station links the Rosario Master Control Station, the Napindan Hydraulics Control Structure, Department of Public Works and Highways Central Office and PAGASA Compound through its modern telecommunication facilities. It is located inside the Town and Country Subdivision in Antipolo, Rizal.

PAGASA DATA INFORMATION CENTER. Together with the Napindan Hydraulics Control Structure, and the Department of Public Works and Highways Central Office, the PAGASA Data Information Center also monitors data received from the 2 rain gauge stations and 9 waterlevel stations via the Antipolo Relay Station. It is located within the PAGASA Compound in Diliman, Quezon City.

ROSARIO MASTER CONTROL STATION. The Rosario Master Control Station is located at the right bank side of the Rosario Weir in Pasig City. It houses EFCOS' major telecommunication, telemetry and warning equipment, as well as advanced computer equipment to process and analyze hydrological data coming from the different places of Metro Manila and Rizal.

PHASE 1 EFCOS CONFIGURATION

PHASE 2: 2001

- The project includes the installation of hydrological observation stations
- Under Grant Aid Program and project cost is 411M PhP
- Deployment of emergency radio communication equipment
- Introduction of digitized telemetry system
- Introduction of flood forecasting system

Rainfall Gauging Stations

1. Mt. Campana
2. Boso-Boso
3. Aries
4. Mt. Oro
5. Nangka
6. Napindan
7. Science Garden

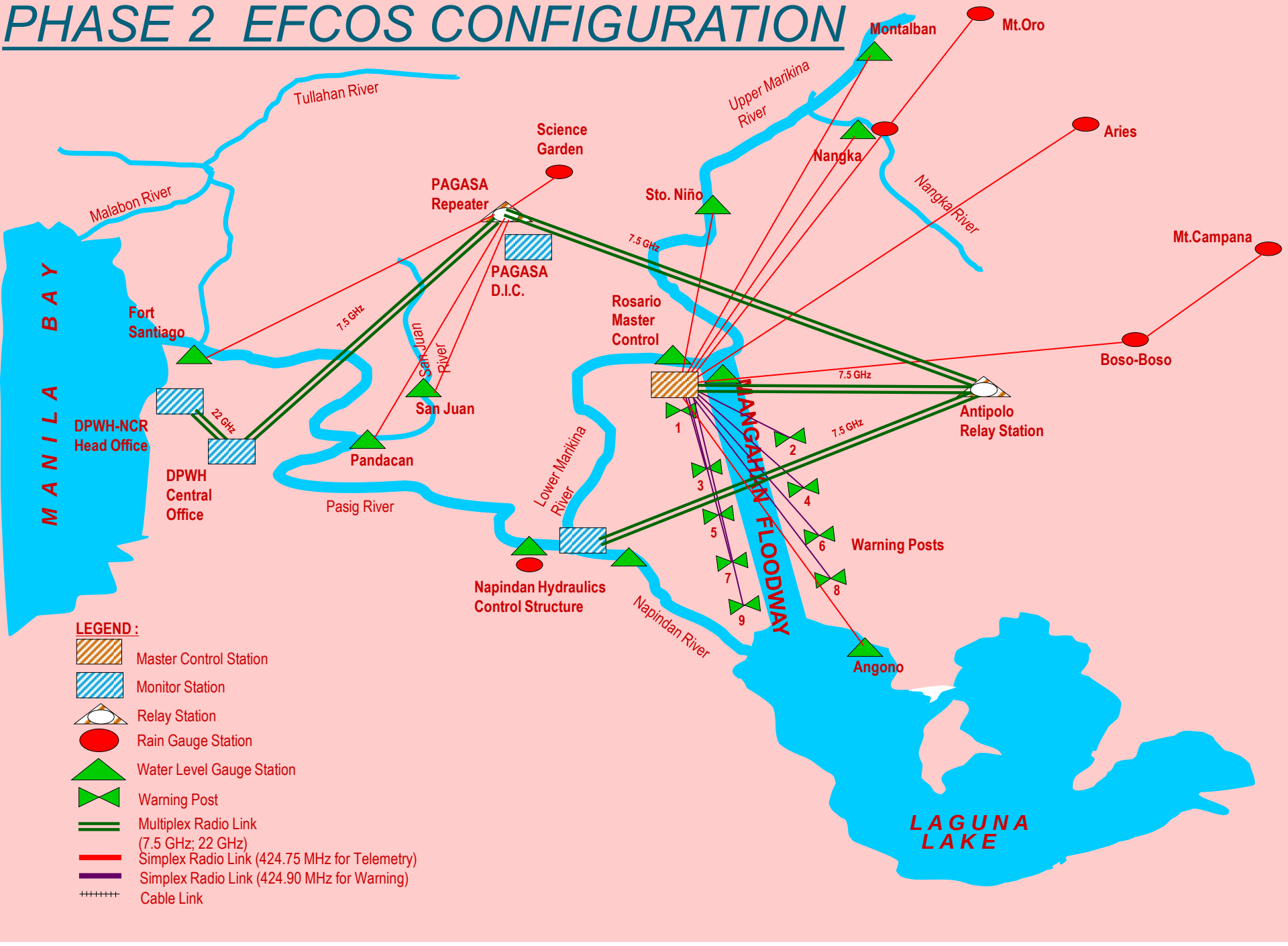
Water Level Gauging Stations

1. Montalban
2. Nangka
3. Sto. Niño
4. Rosario Junction Side
5. Rosario Lake Side
6. Angono
7. Napindan Junction Side
8. Napindan Lake Side
9. San Juan
10. Pandacan
11. Fort Santiago

LEGENDS:

- Additional gauging station
- Existing gauging station

PHASE 2 EFCOS CONFIGURATION



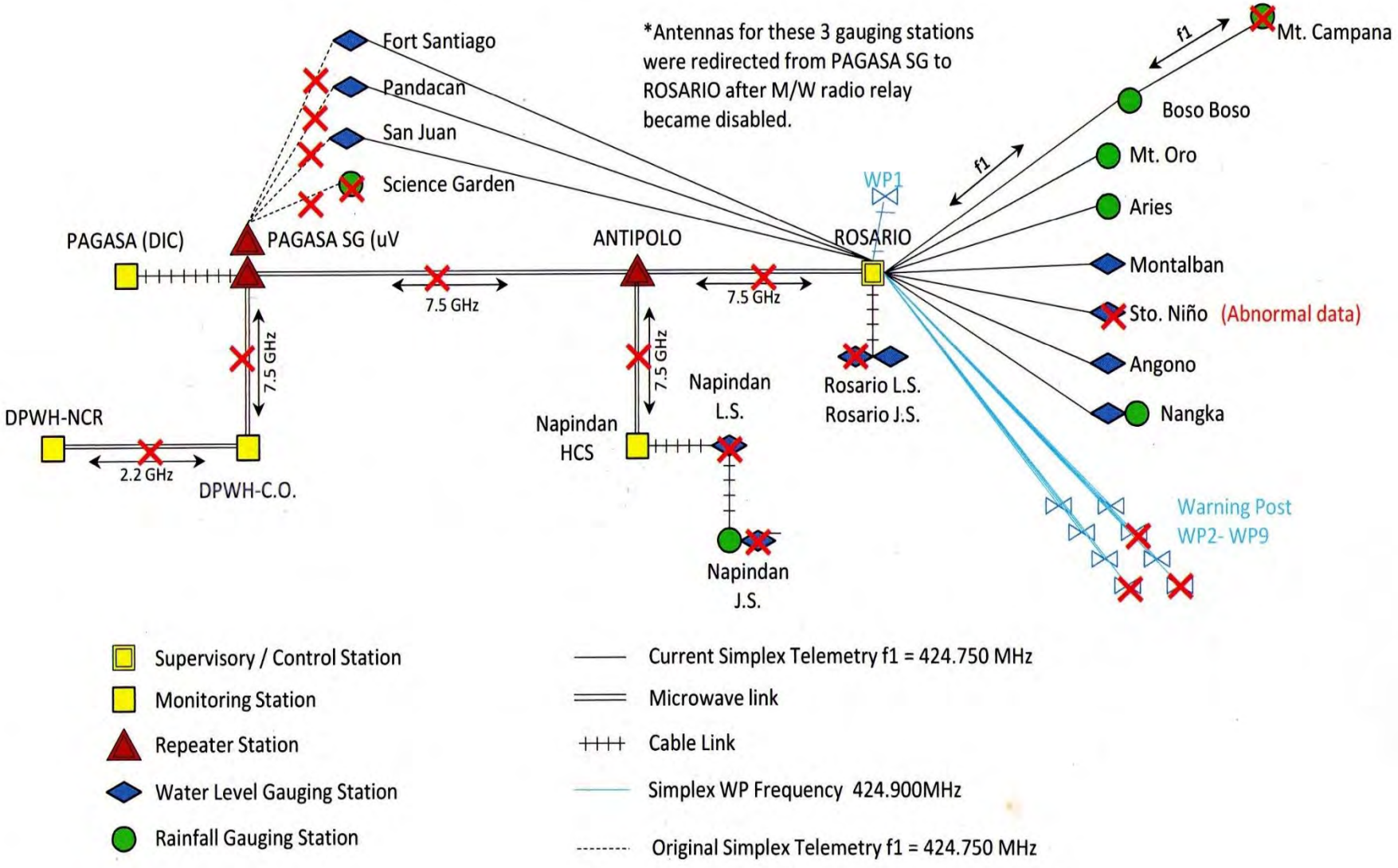
….but some of the telemetry equipment were severely damaged..

Typhoon "Ondoy"

History of Damage Equipment

N0.	STATION	CAUSE OF DAMAGE	DATE DAMAGED	CURRENT STATUS
1	Rosario L.S.	Typhoon "Lagalag"	Aug.02,2002	Manual reading after malfunction
2	Napindan L.S.	Sensor malfunction	Aug.28,2002	Manual reading after malfunction
3	Fort Santiago (Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Redirection of yagi antenna
4	Pandacan (Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Redirection of yagi antenna
5	San Juan (Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Redirection of yagi antenna
6	Science Garden(Mux Problem)	Tropical Depression "Neneng"	Oct.01,2006	Telemetry replaced to Nangka
7	Napindan J.S./Rainfall	Multiplex system failure	Oct. 12,2006	Manual reading of waterlevel
8	Antipolo Relay Station	Multiplex system failure	October 2006	Shutdown
9	DPWH C.O.	Multiplex system failure	October 2006	Shutdown
10	DPWH N.C.R.	Multiplex system failure	October 2006	Shutdown
11	Nangka	Typhoon "ONDOY"	Sept. 26, 2009	Replace w/ S.G. telemetry unit
12	Sto.Nino	Typhoon "ONDOY"	Sept. 26, 2009	Cable was submerged
13	Warning Post No. 8	Typhoon "ONDOY"	Sept. 26, 2009	Warning eqpt. was submerged
14	Mt. Campana	Hit by lightning	2009-2010	Telemetry eqpt. was damaged
15	Science Garden R.F.	Reed switch problem	Nov.19,2010	Replaced w/ Napindan tipping bucket
16	Aries R.F.	Reed switch damaged by ants	Mar.03,2011	Replaced with spare tipping bucket
17	Boso-Boso R.F.	Reed switch problem	Sept.7,2011	Replaced with spare tipping bucket
18	Warning Post No. 2	Damage by rodents	Jan. 11,2012	Operational after repair
19	Warning Post No. 4	Stolen	May 14,2012	Shutdown
20	RMCS Server	Server sometimes malfunction	July 27,2012	New sensor under PAGASA Project
21	San Juan	Interference	June 09,2014	Install additional amplifier

Source: JICA Study Team



Status of the EFCOS Telemetry and Warning System before Rehabilitation

Source: MMDA

PHASE 3: 2015

- It is under JICA's Technical Cooperation Program (TCP)
- Project costs:
  Government of Japan: 129,000,000 JPY
  Government of Philippines: 16,000,000 PhP
- Improvement/Replacement of damaged equipment
- Relocation of currently used frequency for Telemetry and Warning Stations
- Restore the original objectives of EFCOS

Work Responsibilities of MMDA

STATION	WORKS	CURRENT STATUS
Monitoring Stations	Clearing the site including pulling out of unnecessary equipment and storing them in in the Rosario Master Control Station before disposal	COMPLETED
Science Garden Rainfall Gauging Station	Renovation of observation house • Repair of Door	COMPLETED
Boso-Boso Rainfall Gauging Station	• Repainting of antenna mast • Repair door hinge	COMPLETED
Napindan HCS	1. 35 m Antenna Tower • Removal of tower • Transfer/mobilization from NCR to NHCS • Construction of tower foundation • Erection/Installation of tower 2. Repair of water level sensor box 3. Water proofing and improvement of building with air conditioning	COMPLETED
Warning Post No. 8	Construction of 2nd floor	COMPLETED
Mt. Campana	Erection of additional antenna pole	COMPLETED
Nangka Rainfall Gauging Station & Water Level Gauging Station	Renovation of observation house • Construction of 2nd floor	COMPLETED
Sto. Niño Water Level Gauging Station	Repair of telemetry house door	COMPLETED
Fort Santiago Water Level Gauging Station	Repainting of antenna mast	COMPLETED
Antipolo	Room renovation with air conditioning	COMPLETED
Angono Water Level Gauging Station	Water-proofing and construction of security fence	COMPLETED
All	Necessary GOP procedures for an official request for GOJ on disposal of equipment provided under Grant Aid Project	

Work Responsibilities of MMDA


Warning Post No. 8 (BEFORE)


Nangka (BEFORE)


Napindan Tower (BEFORE)

AFTER


AFTER


AFTER

Work Responsibilities of MMDA


Napindan HCS (Before)

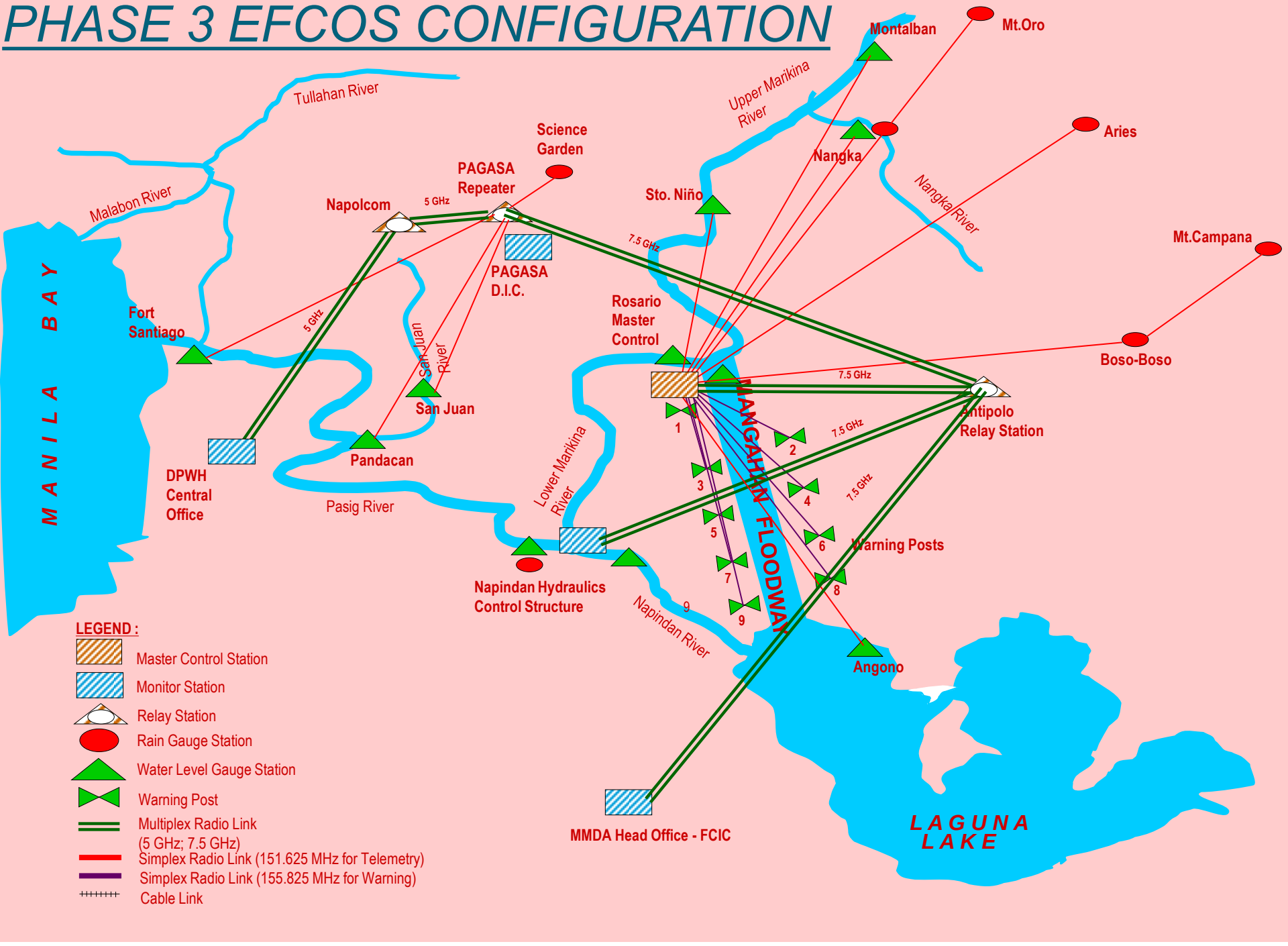

Antipolo (Before)

Antipolo (After)


Napindan HCS (After)


Napindan (Now)

PHASE 3 EFCOS CONFIGURATION



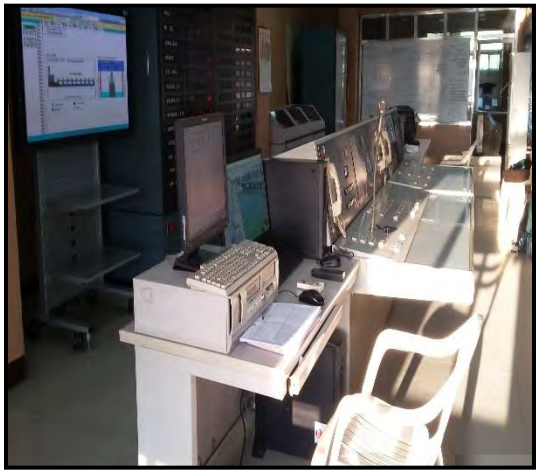
EFCOS

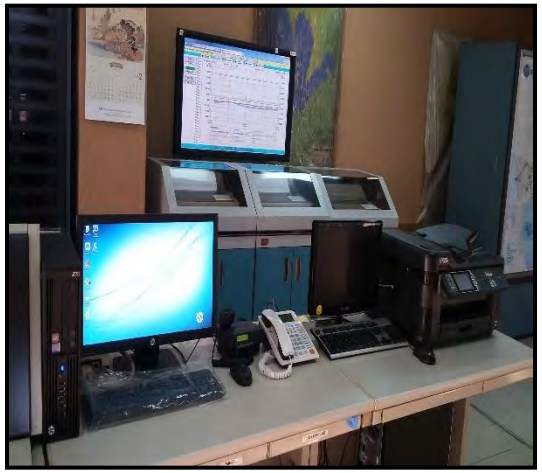
COMPONENTS

PHASE 3

Rosario Master Control Station

- Located at the West Bank side of the Rosario Weir along Manggahan Floodway





- It houses EFCOS major telecommunication, telemetry and warning equipment as well as advanced computer equipment

- The key station that supervises and controls all of the above mentioned equipment

Rainfall Gauging Station

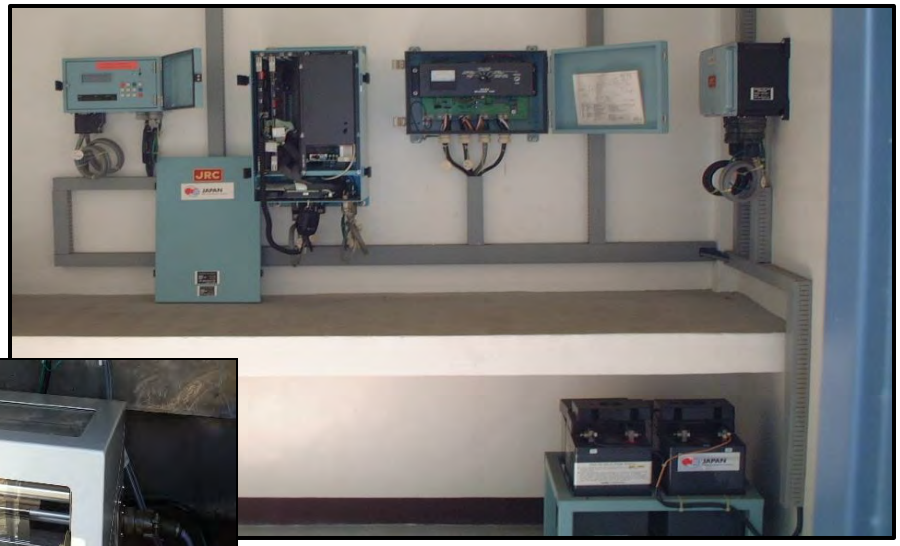
- Used for measuring the amount and intensity of precipitation

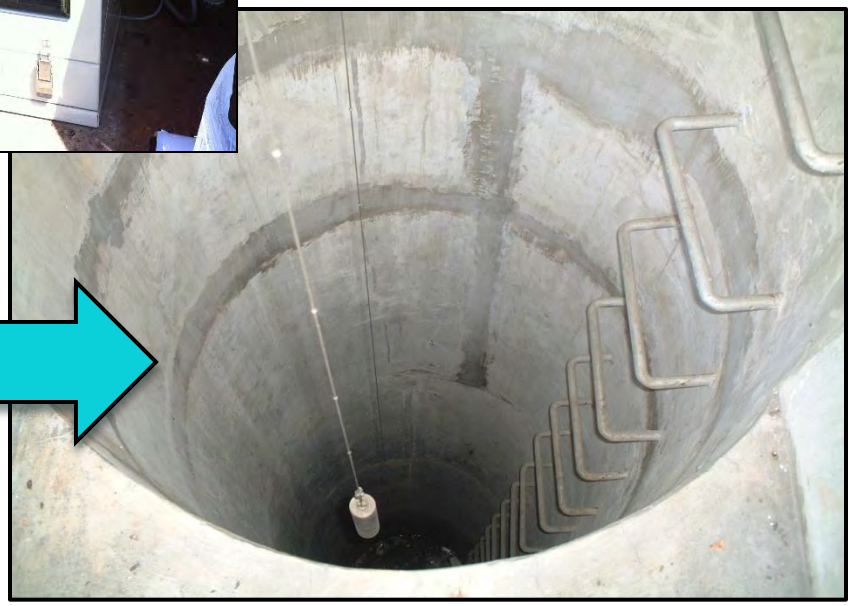
TIPPING BUCKET

- Also used for determining the time of beginning and ending of precipitation

Water Level Gauging Station

A structure inside or close to the stream channel which records the height of water surface in the stream





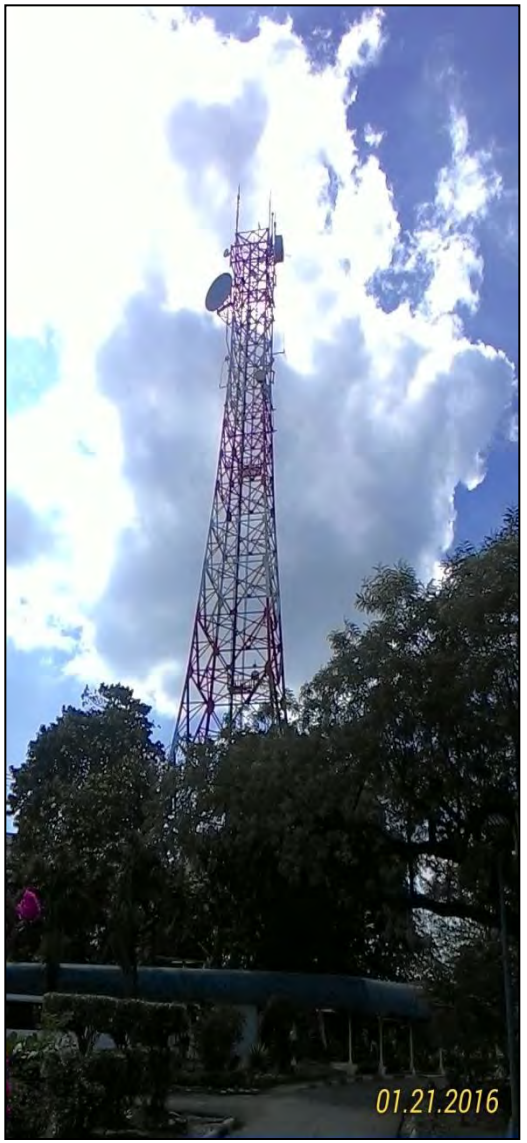
FLOAT TYPE - a wire connected to flat circular wooden float, counterweight, Analog to Digital converter and automatic recorder

Relay Station

- This station is the relay point for the multiplex communication system of EFCOS Project

- The master station for the multi-directional multiplex radio system and other slave stations such as rainfall and water level gauging stations

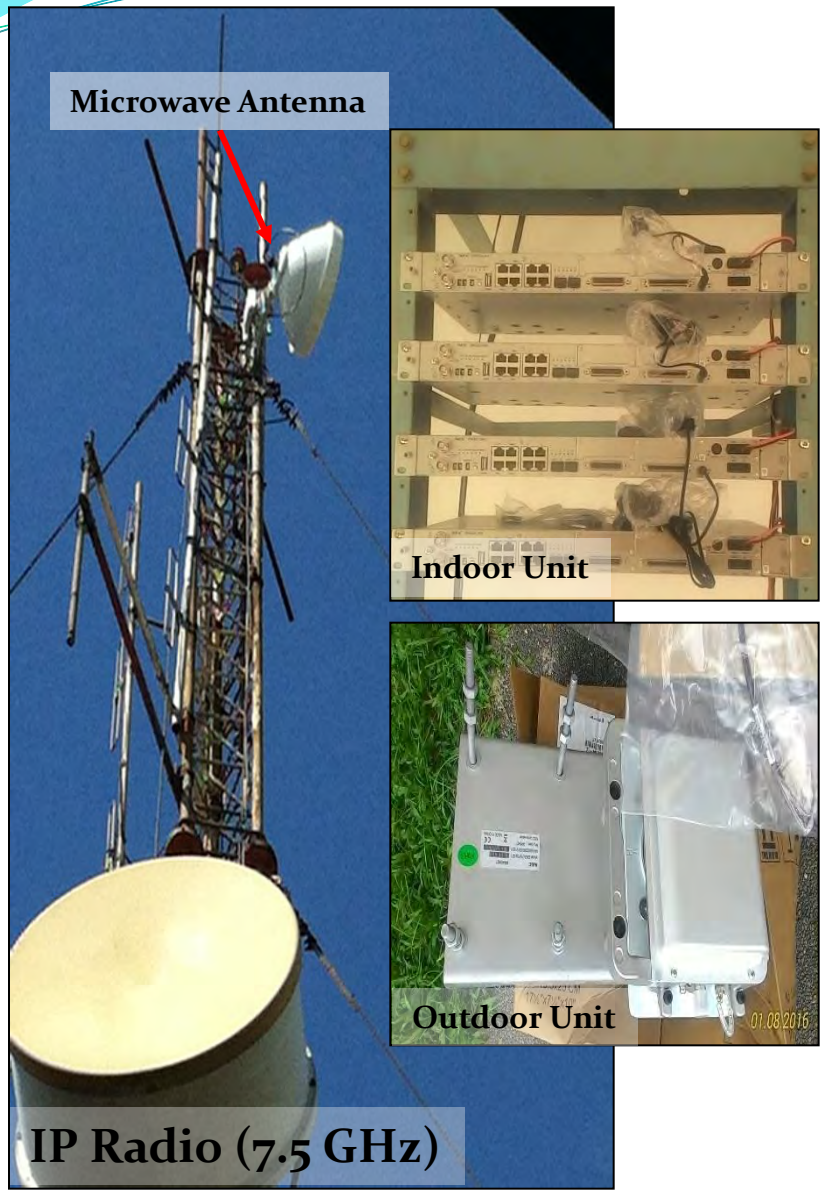
- The function of relay stations is to make sure that the data and voice transmission between the said stations will be made possible

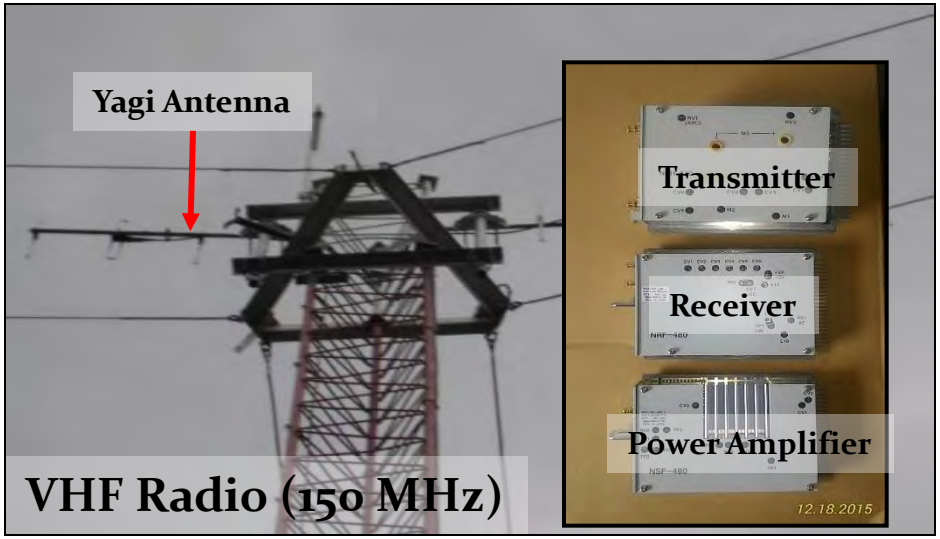


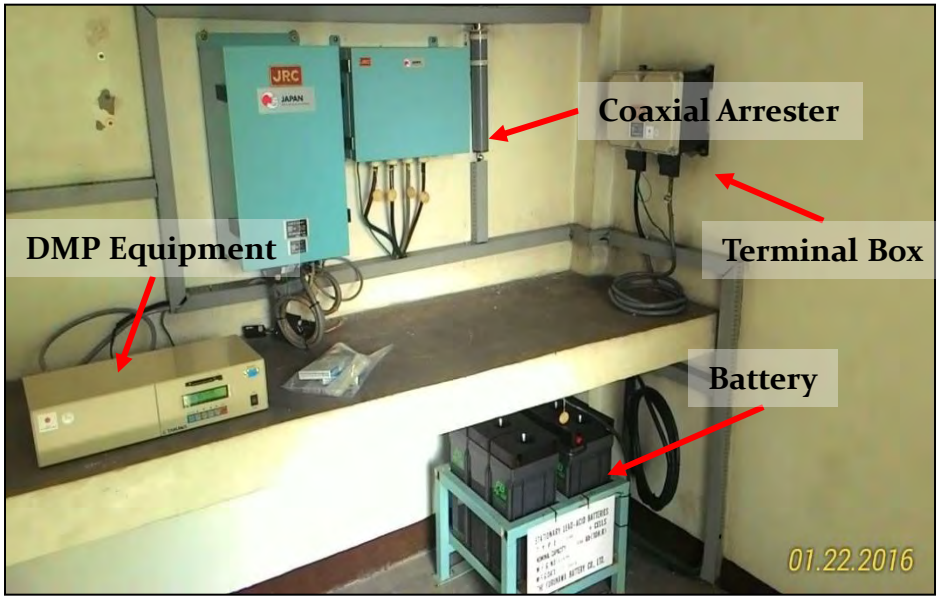
Warning Post

- Alert people along the floodway
- Warning Post 1 is Rosario located inside the Master Control Station
- Remaining eight are situated on the east and west main dikes of Manggahan Floodway Channel
- Connected to the RMCS through cable and Very High Frequency (VHF) radio

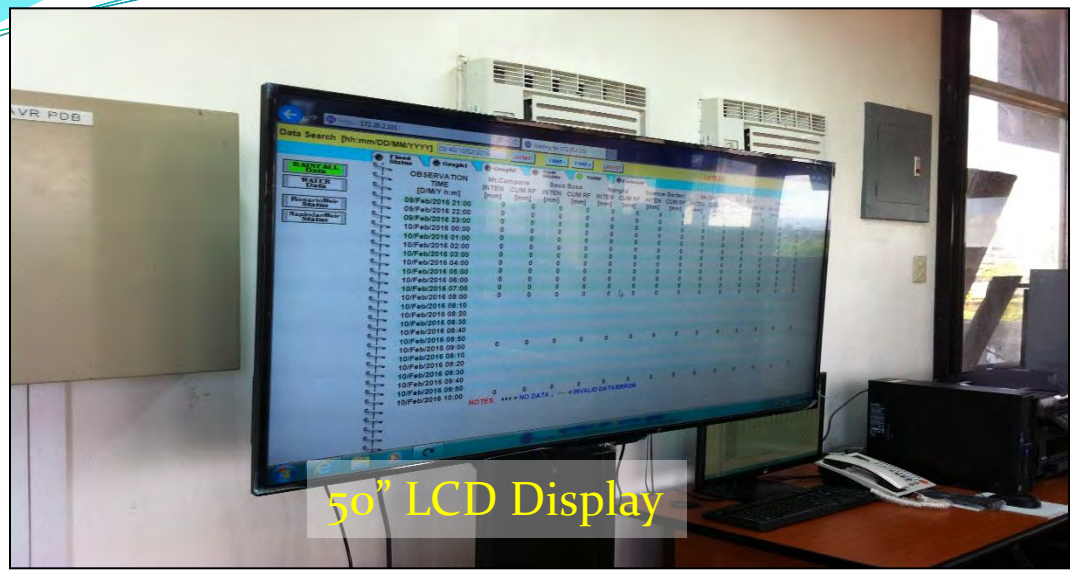
Newly Installed Equipment

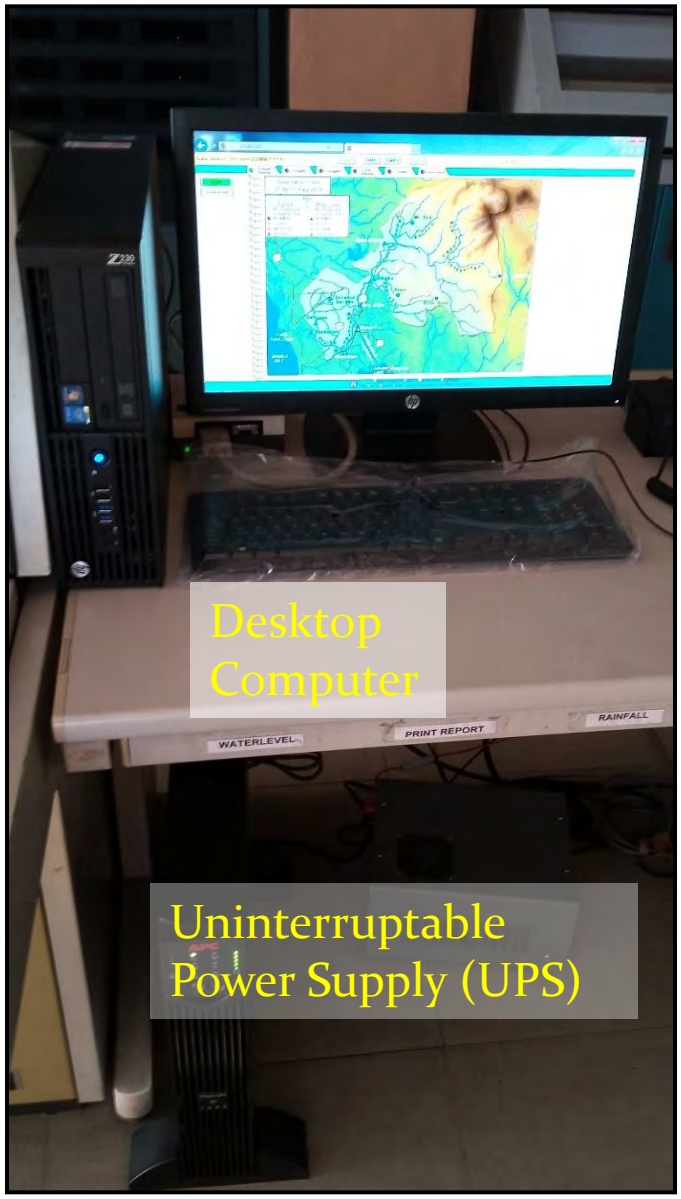




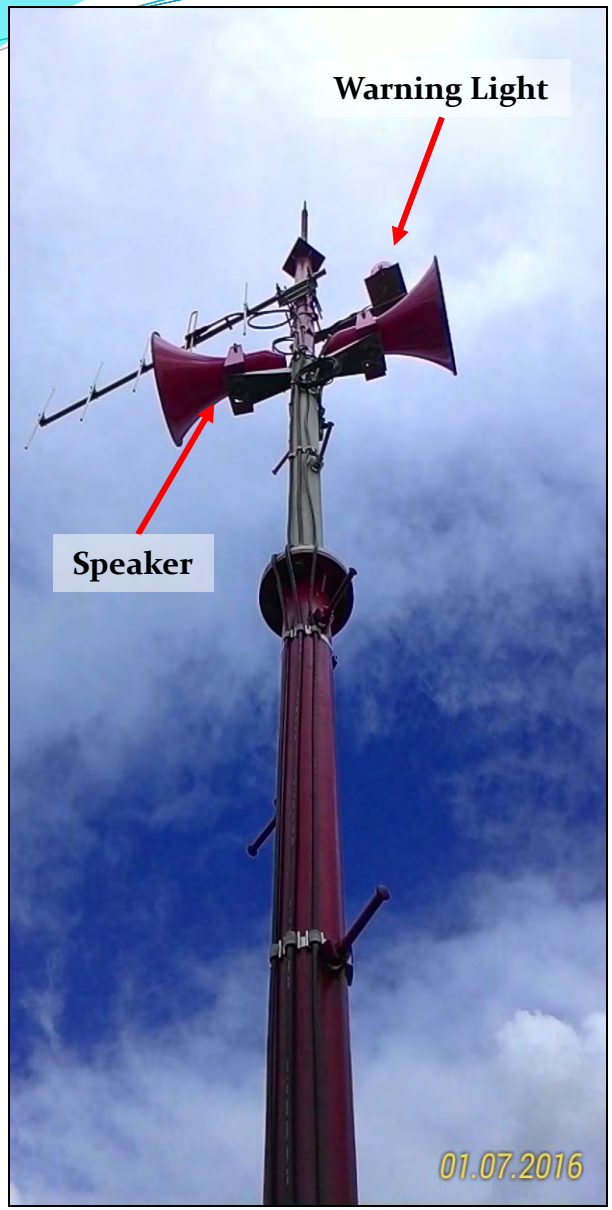


Newly Installed Equipment





Newly Installed Equipment



Flood Forecasting and Gate Operation

Travel Time (Flood Propagation)

River	Section	Travel Time (min.)	Distance (km)	Propagation Velocity (m/s)
Upper Marikina River	Montalban - Nangka	80	9.0	1.9
	Nangka – Sto. Niño	50	5.3	1.8
	Sto. Niño - Rosario	30	6.7	3.7
San Juan	Tatalon - Junction	30	7.1	3.9

Water Level Status

Status	Pasig-Marikina River					Tributary	
	Montalban	Sto. Niño	Rosario	Napindan	Pandacan	San Juan	Nangka
Critical	23.6	14.9	13.8	12.9	12.0	12.0	18.3
Alarm	23.0	14.1	13.2	11.9	11.5	11.5	17.7
Alert	22.4	13.0	12.5	10.9	11.0	11.0	17.1

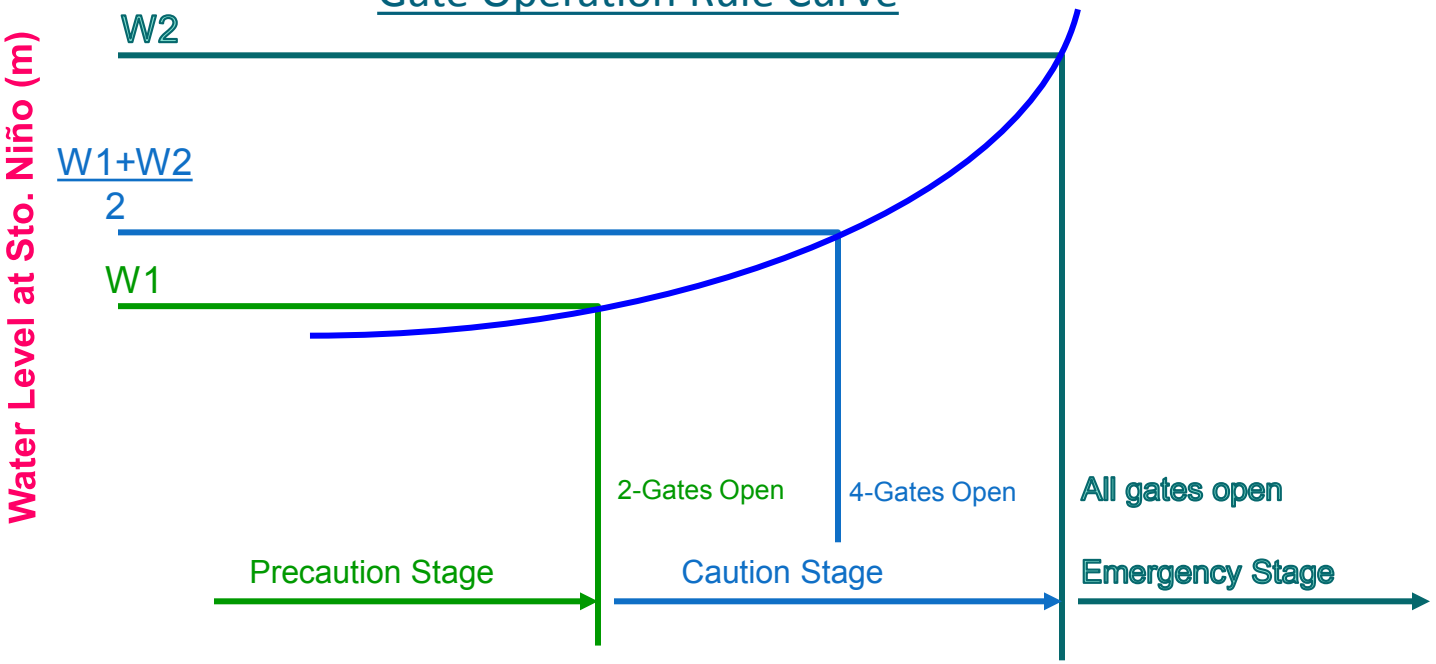
Rainfall Status

Status	Basin Mean Rainfall (mm/hr)
Heavy	Over 50
Moderate	Between 30 and 50
Light	Less than 30

Relationship between Basin Mean Rainfall and Waterlevel

Rainfall Intensity (mm / hour)	Increase of Water Level (m)	
	Montalban	Sto. Niño
10-30	0.1 - 0.6	0.1 – 0.6
30-50	0.6 - 1.2	0.6 – 1.3
50-70	1.2 – 1.8	1.3 – 2.1
70-90	1.8 – 2.2	2.1 – 2.8
90-100	2.2 – 2.5	2.8 – 3.1

Gate Operation Rule Curve



W1	$\frac{W1+W2}{2}$	W2
15.3	16.2	17.1
15.2	16.1	17.0
15.2	16.1	16.9
15.1	15.9	16.7
15.0	15.8	16.6
14.9	15.7	16.4

W1, W2 : Critical Water Level
Sto. Niño : Control Point
Fort Santiago : Tidal Level (m)

2012 REVISED GUIDLINE IN THE OPENING OF GATES AT ROSARIO WEIR

REFERENCE POINT: STO. NIÑO WATERLEVEL GAUGING STATION

STARTING ELEVATION	TOTAL RAINFALL UPSTREAM	FORECAST ELEVATION		GATES TO OPEN AT RANDOM	GATE OPERATION	WHAT TO DO FIRST	REMARKS
		LOW	HIGH		OPEN		
13.50 ALARM	NO RAINFALL MONITORED AT ALL EFCOS RAINFALL GAUGING STATION			ALL GATES CLOSED	0	ISSUE WARNING BEFORE OPENING ALL GATES	If there is no rainfall event yet Sto. Niño reads elevation 13.8m keep all gates closed
13.70 ALERT							If there is rainfall event follow the random opening of gates
13.80 CRITICAL	**LIGHT** 10-30	13.90	14.4	OPEN G4 OPEN G5 OPEN G3 & G6	1 2 4	ISSUE SEVERE WARNING AT ALL WARNING POST STATION	**FIRST ALARM IN MARIKINA LGU (15.00)** **SECOND ALARM MARIKINA LGU (16.00)** **FORCE EVACUATION AT MARIKINA (17.00)**
	LIGHT-MOD 30-50	14.50	15.10	OPEN G2 & G7 OPEN G8	6 7		
	MODERATE 50-70	15.30	15.90	OPEN G1	8		
	MOD-HEAVY 70-90	16.00	16.60		**ALL GATES OPEN**		
	HEAVY 90-100	16.70	16.90				

Maraming Salamat!