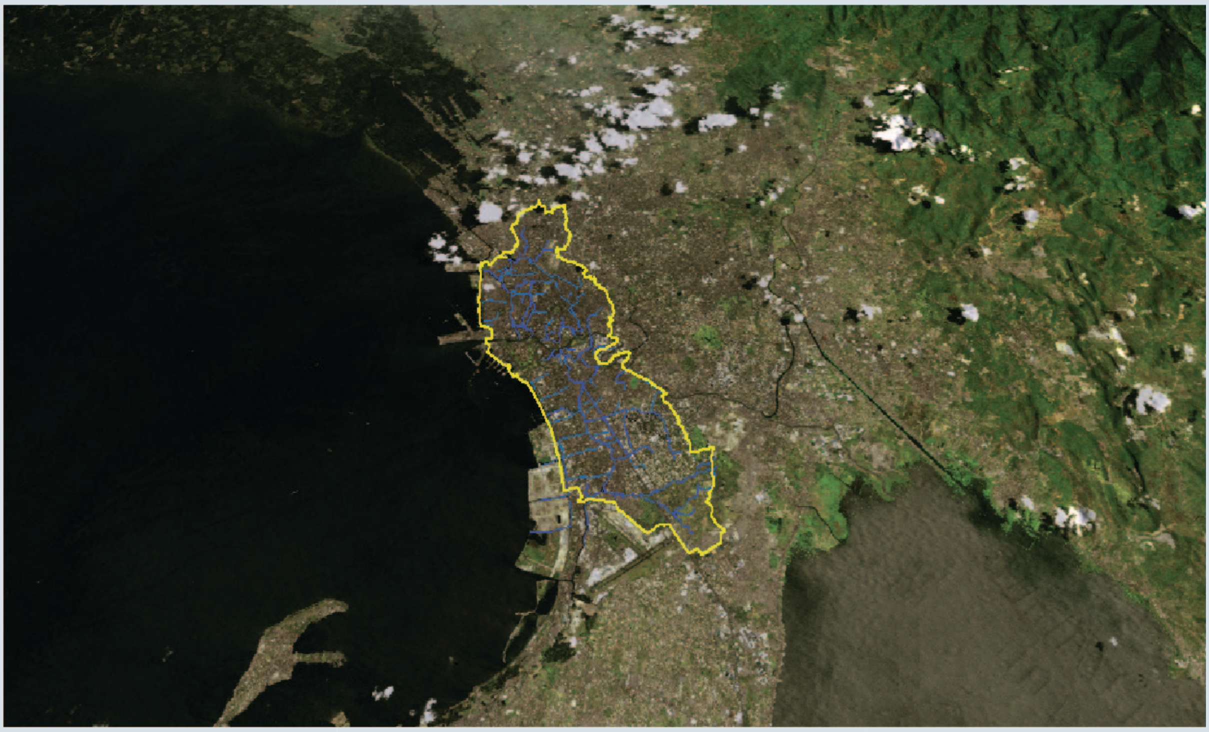
No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

METROPOLITAN MANILA DEVELOPMENT AUTHORITY (MMDA)
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS (DPWH)
THE REPUBLIC OF THE PHILIPPINES

THE STUDY ON DRAINAGE IMPROVEMENT IN THE CORE AREA OF METROPOLITAN MANILA, REPUBLIC OF THE PHILIPPINES

FINAL REPORT
SUPPORTING REPORT
Volume I



MARCH 2005

PACIFIC CONSULTANTS INTERNATIONAL
NIKKEN CONSULTANTS, INC

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Foreign Currency Exchange Rates Applied in the Study

Currency	Exchange Rate/USD
Philippine Peso (Php)	55.0
Japanese Yen (JPY)	110.0

(Rate as of July, 2004)

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A.1 OBJECTIVE OF DATABASE DEVELOPMENT

Main objectives of development of database in this Study are as follows:

- To develop an integrated database of the drainage system in the Core Area of Metropolitan Manila; and
- To develop an easy-to-understand, useful and visualized database, especially for effective O&M activities and sustainable use by managing organizations: DPWH, MMDA and LGUs.

A.2 CONCEPT OF DATABASE STRUCTURE OF THE STUDY

A.2.1 DESIGN OF DATABASE STRUCTURE

In this Study, the data stored in the database are used not only for presenting the condition of the existing drainage system but also for planning and evaluating them in combination with the information of drainage system and various data such as topographical, hydrological, hydraulic, social and economic data. In that case, it is better to have capabilities of processing and analyzing the special (graphic) data/information. In this context, the database is proposed to be developed mainly based on a Geographic Information System (GIS).

GIS has emerged as one of the most powerful tools in decision making and planning. It can handle large volumes of map and attribute data simultaneously. It has a wide range of data analysis functions such as overlay, buffer and attribute manipulation. Because of these capabilities, GIS has been used extensively for urban/regional planning, environmental or natural resource management, tax mapping and facilities management.

Concept of Database Structure of this Study is shown in the following figure.

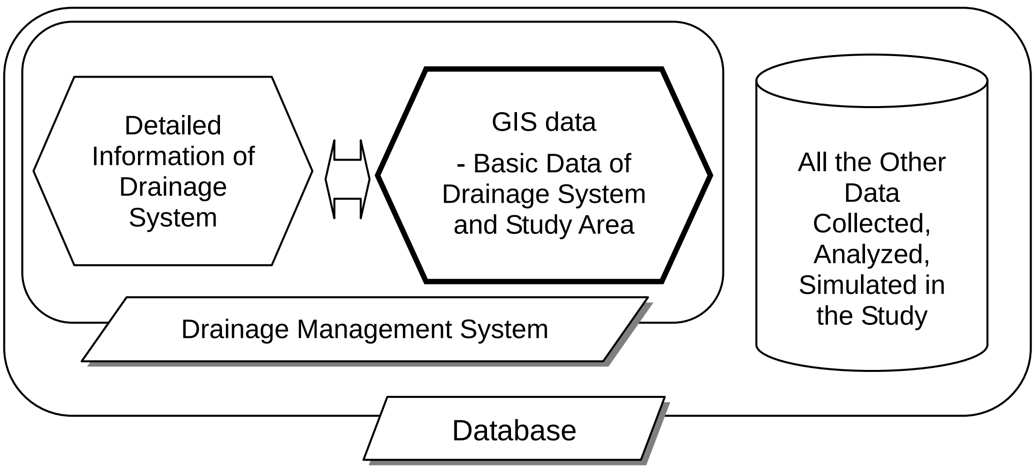


Figure A.2.1 Concept of Database Structure

The database consists of three parts, 1) GIS data including basic data of drainage system and Study Area, 2) detailed data of drainage system, and 3) all the data relating to the Study.

Contents of each part are described below:

1) GIS Data

Fundamental data of the Study Area such as administrative boundary, population, contours, geology, landuse, and infrastructures, and basic data of drainage system and facilities with location, name, completion year, code number, etc. are stored as GIS data classified into specific fields.

2) Detailed Information of Drainage System

Detailed data and information regarding drainage system and drainage facilities, which are difficult to input as GIS data due to the data type and high frequency of the data addition, are stored. Data include not only drawing data of cross-section and longitudinal profile of drains, and operating condition of drainage facilities but also records for daily O&M activities and pictures. The data are linked with GIS data of drainage system and drainage facilities, and users can find out the relation between these data and GIS data from GIS application.

3) All the other data regarding the Study

The other data, mainly raw data collected and analyzed in this Study, such as rainfall data, questionnaire survey data, and geological data, are stored in order to avoid data missing and to utilize the data not only for this Study but also for the other projects in future. Data are categorized and stored in specific fields.

The above 1) and 2) constitute the main part of the database of this Study, which is named Drainage Management System.

A.2.2 BASIC DATA FOR DATABASE OF THE STUDY

In Metropolitan Manila, multi-purpose database was already developed in the Study of "Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines, (hereinafter referred to as "MMEIRS")" in 2004 by JICA. Regarding the database of drainage system, it was developed in "Study on the Existing Drainage Laterals in Metro Manila in the Republic of the Philippines (hereinafter referred to as "SEDLMM")" conducted by JICA in 2000.

Contents of each database are summarized as follows:

- Database of MMEIRS (grid coordinate system: the Philippine Transverse Mercator (PTM))
  1) Database (ArcView data)
     - Natural Conditions: Contour, river, etc.
     - Social Conditions: Barangay boundary, city boundary, population, land use
     - Infrastructures: Road, railway, airport
     - Buildings: All the houses in Metropolitan Manila
     - Public facilities: Hospital, school, etc.
  2) 1:5,000 Digital Map (CAD Drawing)
  3) Ortho-photos

- Database of SEDLMM (grid coordinate system: the Philippine Transverse Mercator (PTM))
  1) 1:2,500 Drawings (CAD Drawing)
     - Drainage system: Esteros, drainage mains, laterals and manholes
     - Drainage Facilities: Pumping Stations, Control Gates
  2) Database of manhole (Microsoft Access data)

3) Inundation data of 1999 flood (CAD Drawing & Microsoft Access data)

It is often the case that these data are not suitable for the database of this Study due to the difference of the purpose and approach of the database construction, even though these databases were well-developed. For example, MMEIRS database are well-arranged as GIS data, but information of drainage system is insufficient for this Study because the main purpose of the Study is earthquake impact reduction. And SEDLMM database is specified in drainage system, but inconformity of location from CAD data and Access data is occasionally found so that database is not arranged as GIS data.

Therefore, in this Study, the database are developed modifying and importing the above existing database, and inputting the new data, which are collected, analyzed and simulated in the course of this Study.

A.2.3 NECESSARY APPLICATION

In this Study, the database is decided to be developed mainly by using the database function of GIS software of ArcView 8.* with following considerations:

- Amount of data handling in the database;
- Popularity of Software;
- Easiness of operation for data processing/analyzing; and
- Easiness of conversion of the database files to other database format.

After completion of this Study, the data will be distributed to concerned agencies such as MMDA and LGUs, because those agencies are responsible for conducting daily O&M activities. But it is possible that some agencies are not able to prepare the software due to the budgetary deficit. Therefore, free software provided by distributing company of GIS software is also included in the system and distributed to them, so that at least users can see, check and use the data without any particular software.

A.3 DATABASE FOR THE STUDY

A.3.1 PROCEDURE OF DATABASE DEVELOPMENT

Procedure of database construction is shown in the following figure.

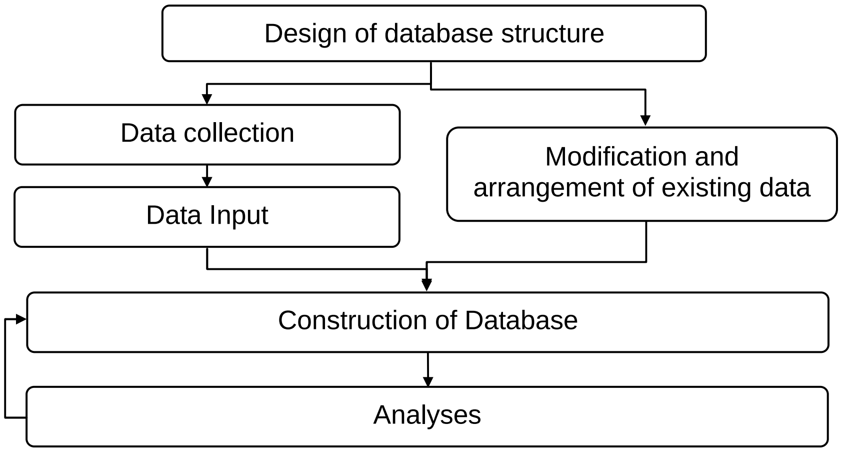


Figure A.3.1 Procedure of Database Development

Data collection, data input and modification and arrangement of existing data are time consuming but most important, because these are based on all the analysis of the Study, and these determine the degree of accuracy. Many data were newly input and re-arranged, and analyses used the data were conducted and the results were also input to the database. Data were input as GIS data as much as possible.

In order to construct the valuable and useful database, systematic arrangement of the data as well as the above procedures are essential. All the data were arranged systematically as users can understand the data structure and correlation of the data easily.

A.3.2 DATABASE STRUCTURE

Database structure is shown in *Figure A.3.2*.

As mentioned in A.2.1, the database consists of three parts, 1) GIS data including basic data of drainage system and Study Area, 2) detailed data of drainage system, and 3) all the data relating to the Study. In the actual database, the above three parts are organized as “GIS_Data,” “DrainageManagementSystem,” and “StudyDataAggregate” folders respectively.

Contents of each folder are described below.

(1) GIS_Data

This folder contains all the GIS data and data list of GIS data. GIS data are stored in “Shape” folder. First, it classified into three, “ExistingConditions,” “MasterPlanPlaning” and “Simulation.” The data of “MasterPlanPlaning” and “Simulation” folders are especially for Master Plan and its evaluation for this Study, and volume of these data is small. Almost all the data are categorized into 15 fields and put in “ExistingConditions” folder as shown in *Figure A.3.2.* Some of fields/folders have sub-folders as easy-to-recognize. For example, “DrainageSystem” folder has five sub-folders, in which two to nine GIS files are stored.

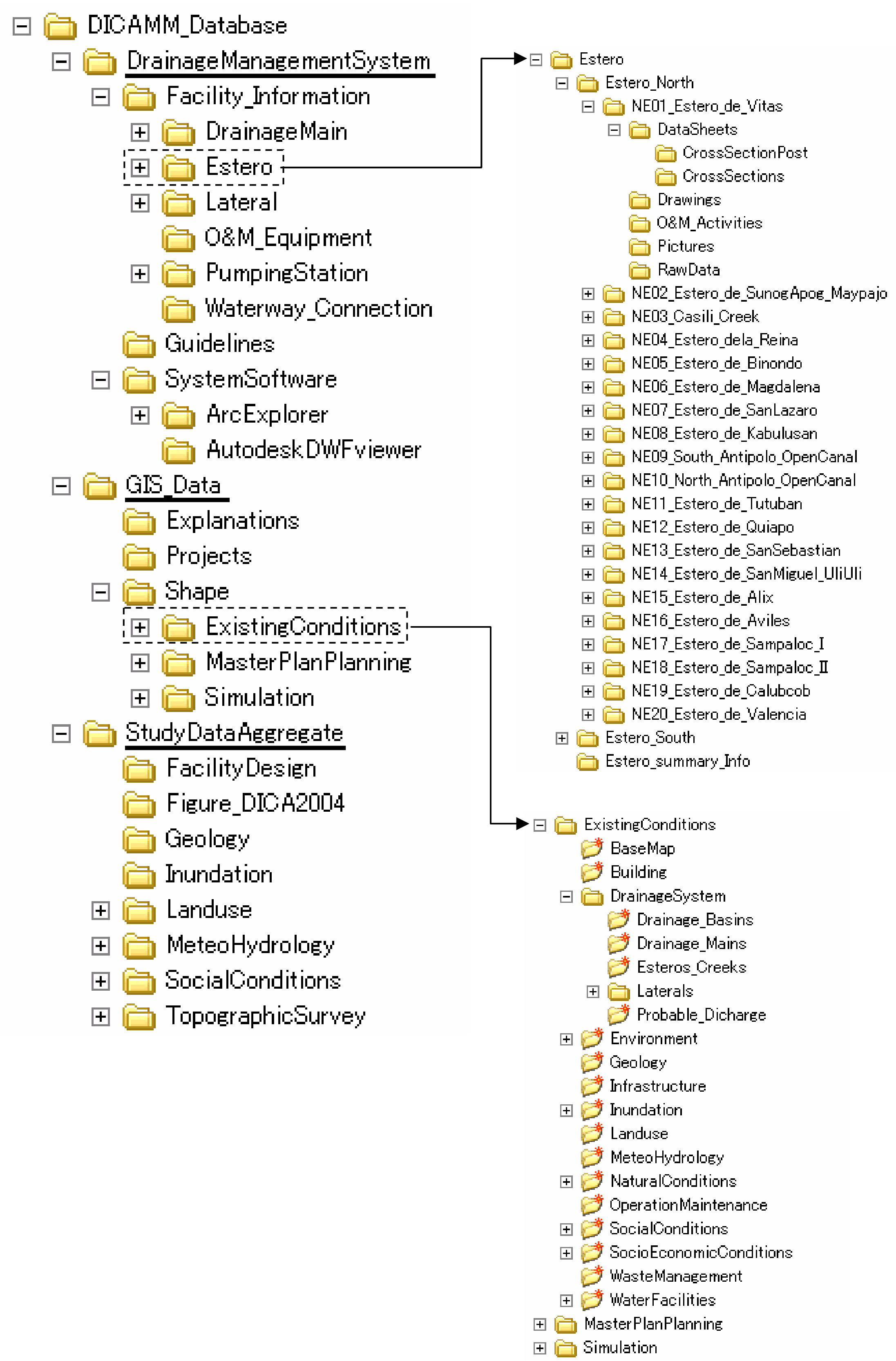


Figure A.3.2 Database Structure

Table A.3.1 shows a list of GIS data. Every GIS data has not only spatial data but also various attribute data such as code number, name, length, specification of facilities, and survey results. *Table A.3.2* is a detailed list of GIS data including all the attributes and those detailed explanation. These lists are put in “GIS_Data¥Explanations” folder.

GIS data regarding estero, drainage main, pumping station and operation and maintenance have the attribute indicates a linkage with “DrainageManagementSystem” folder as shown in *Figure A.3.3*. As for these data, many kinds and types of data are collected through this Study and got together in “DrainageManagementSystem” folder. When users see the indicated folder, they can get more detailed information of them.

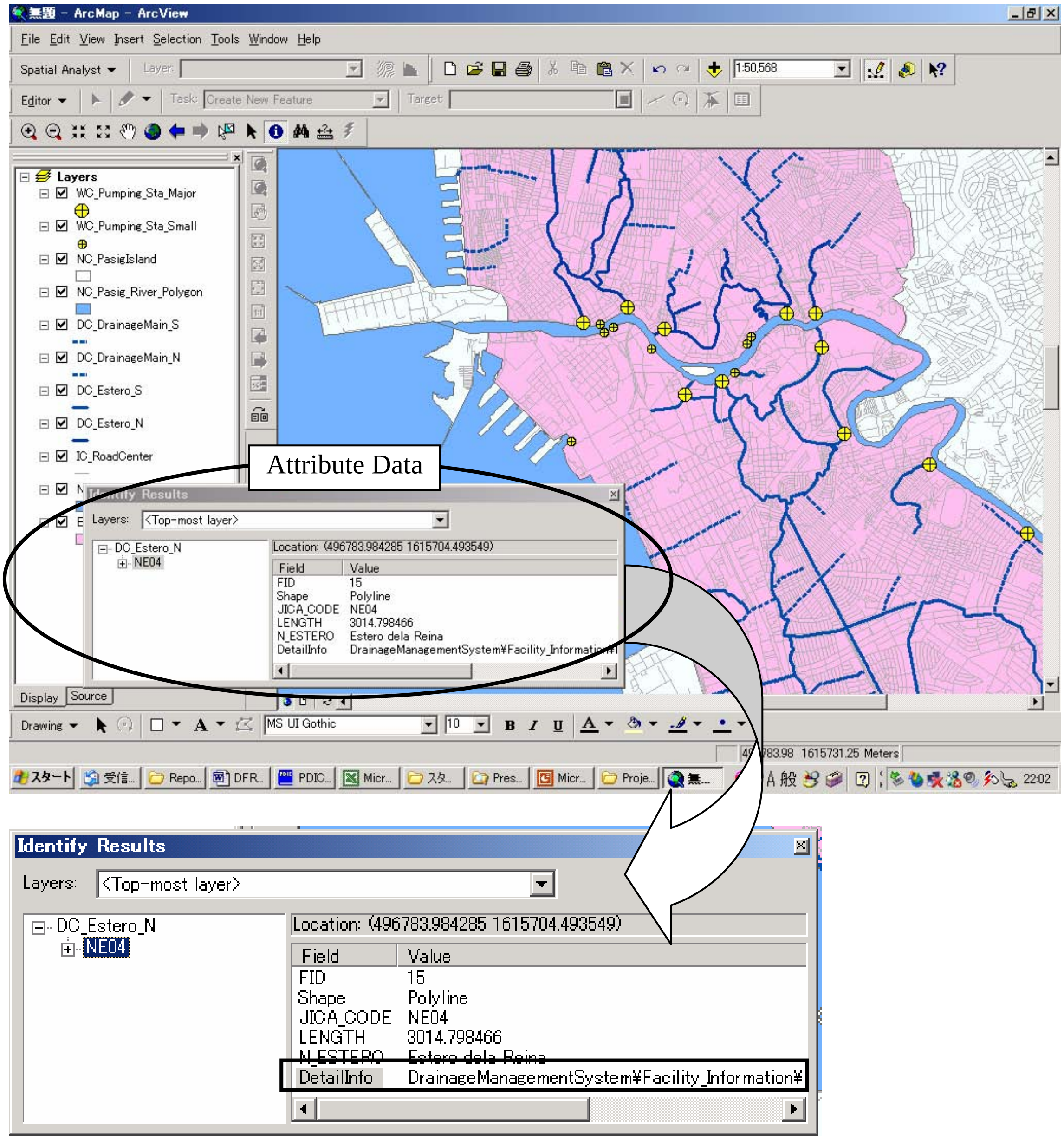


Figure A.3.3 Example of GIS Data and its Attribute

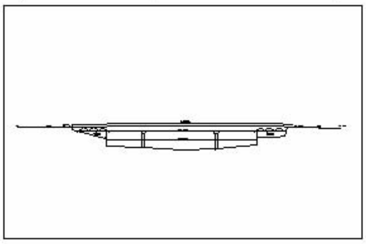
(2) DrainageManagementSystem

This folder includes 1) detailed data and information especially regarding drainage system and drainage facilities, 2) guidelines for planning, design, construction and O&M of drainage system and facilities, and 3) free softwares for using drainage management system.

"Facility_Information" folder is for detailed data and information, which are difficult to input as GIS data due to the data type and high frequency of the data addition. This folder is categorized into sub-folders by facilities. Each sub-folder is segmentized further and segmentized folder contains various data such as drawing of cross-section and longitudinal profile of drains, operating condition of drainage facilities, and pictures. Some of the folders are empty at present, but these will become very much useful in future especially for O&M activities if the data continue to be added in these folders. The following figure shows an example of data sheet, which is put in "DataSheets" folder under "Estero" sub-folder.

Cross Sectional Survey

Code	Chainage	0+000	Surveyor	F. CANCIO
NE01	Date	03-27-04	Checker	M. LOPEZ



Summary of Condition

Channel Bed		2	(1.Garbage 2.Sand and Silt 3.Gravel 4.Vegetation 5.Concrete)
Right Bank	Structure	1	(1.Vertical wall 2.Slope 3.Natural)
	Material	1	(1.Concrete 2.Steel 3.Earth)
Left Bank	Structure	1	(1.Vertical wall 2.Slope 3.Natural)
	Material	1	(1.Concrete 2.Steel 3.Earth)
Land Use		1	(1.Road 2.House or Building 3.Informal Settler)

Bridge	Width	18.20m	
	Type	2	(1.Steel 2.Concrete 3.Wood)
Drainage	Number of Cell		
	Dimension		W = m, H = m
	Elevation of Invert Level		
Remarks:	BOTH BANKS OCCUPIED BY SHANTIES		

Figure A.3.4 Example of Data Sheet

- **Utilization of Database for O&M Activities**

  Records of daily, monthly and yearly O&M activities should be kept. Folders for storage of O&M records are prepared in "DrainageManagementSystem" folder of the database as shown in *Figure A.3.5.*

  Various kinds of records regarding O&M should be made and kept as described in "O&M part of guidelines in Supporting-M." At this moment, detailed database structure for folders of "O&M Activities" are undefined. Eacn agencies/users can design own and useful sturucture for keeping data. However, contents and structures should be discussed among all the concerned agencies periodically and should be modified so as to be easy-to-use and efficient.

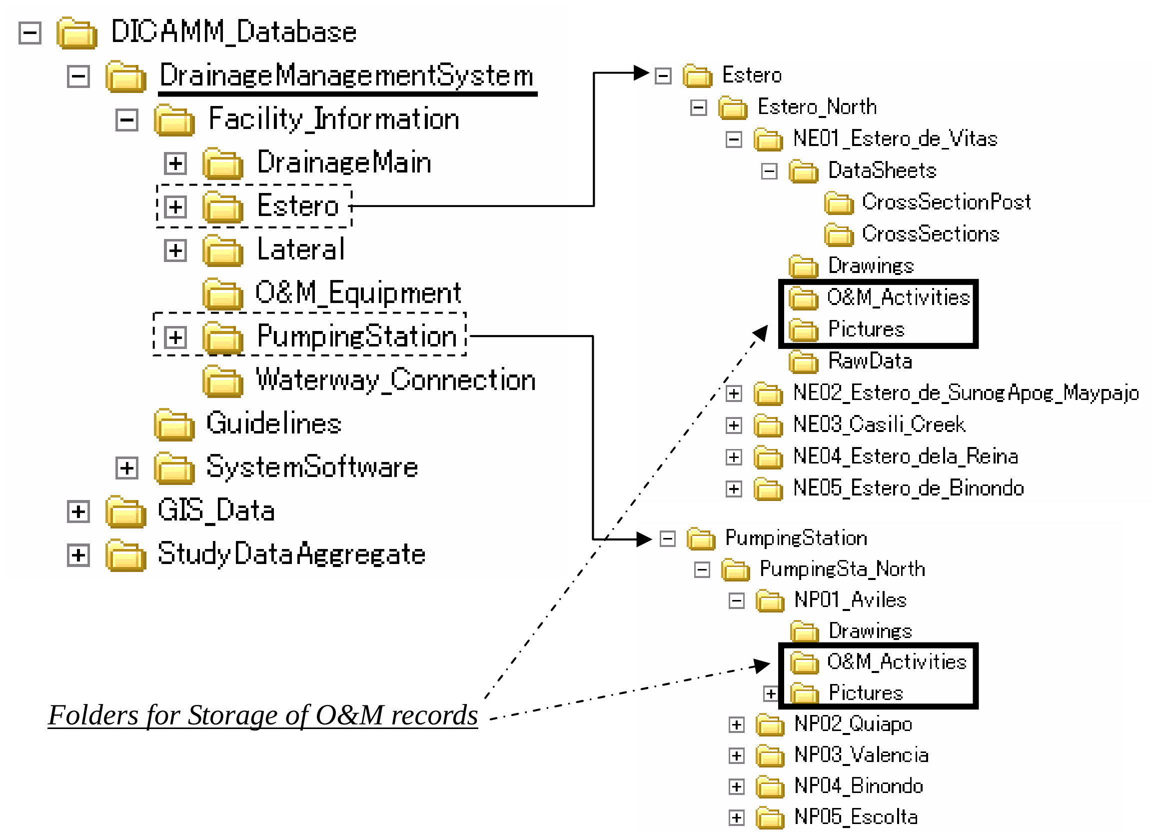


Figure A.3.5 Sample of Folders for O&M Records

In order to use this database, six kinds of softwares are needed, which are Microsoft WORD, Microsoft EXCEL, Adobe Acrobat Reader, software for images, software for CAD drawing and software for GIS. Among them, softwares for CAD drawing and GIS may be difficult to prepare due to budget deficit of users/agencies. Therefore, free softwares for them are put in "SystemSoftware" folder. Users can see and check the CAD drawing and GIS data installing these softwares.

(3) StudyDataAggregate

This folder contains the other various data, which are collected, analyzed and made in this Study, such as landuse maps, Meteo-hydrological data and figures showing the results of the Study. This folder aims to avoid data missing and to utilize the data not only for this Study but also for the other projects in future. It is also expected to contribute to save the time for data gathering in the other projects. The data are categorized and stored in specific fields.

A.4 RECOMMENDATION FOR EFFECTIVE AND SUSTAINABLE USE

Once the integrated database is constructed, a large-scale modification is unnecessary especially as for GIS data in case that drainage system or conditions of Study Area will not change drastically. Instead, a part of the database directly linked to O&M activities ("DrainageManagementSystem" folder in this database) should be updated routinely in order to utilize and sustain the database effectively for future O&M activity as well as actual one.

Consequently, the following are recommended.

1) To distribute the database to all the concerned agencies.
2) To assign the person who can grasp the contents of database and has technique to add and input the data, in the units in charge of O&M activities of each agencies.
3) To update and input data routinely in each unit, and to modify the database structure such as making new folders if necessary.
4) To hold a meeting of concerned agencies periodically, in order to share the data which each unit input, integrate all the data at least to principal agency's database and discuss the database structure so as to be easy-to-use and efficient.
5) To review the database especially the part of GIS data at least once a year. In case that drainage system or conditions of Study Area changes drastically, principal agency modifies the correspondent data and distributes the revised data to all the concerned agencies.

The above activities are able to conduct for the part of daily routine work without any preparation and budget except the minimum equipments, such as computers. Although it is nothing but a first step and the system that is proposed in Clause 4.5 "Improvement of Operation and Maintenance System" of Main Report is eligible to construct in future times, it should be commenced to incorporate the database into daily O&M activities for a start.

Table A.3.1 List of GIS Data (1/4)

1. Exsitning Conditions

	File Name	*Description*
BASE MAP	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\BaseMap	
Study Area	BC_StudyArea.shp	Study Area
	BC_StudyArea_N.shp	Northern part of the Study Area
	BC_StudyArea_S.shp	Southern part of the Study Area
	BC_StudyArea_Buffer1km.shp	Buffer of Study Area
	BC_StudyArea_Mask.shp	Mask of Study Area
	BC_StudyArea_Mask1km.shp	Mask of Study Area

DRAINAGE SYSTEM	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\DrainageSystem	
Esteros/Creeks	DC_Estero_N.shp	Esteros and Creeks in the Northern part
	DC_Estero_S.shp	Esteros and Creeks in the Southern part
	DC_Estero_Section_N.shp	Estero Sections in the Northern part
	DC_Estero_Section_S.shp	Estero Sections in the Southern part
	DC_Estero_Edge_N.shp	Estero Edges in the Northern part
	DC_Estero_Edge_S.shp	Estero Edges in the Southern part
	DC_Estero_Poly.shp	Polygon of Estero
	DC_Estero_CS_N.shp	Cross Section Point of Esteros in the Northern part
	DC_Estero_CS_S.shp	Cross Section Point of Esteros in the Southern part
Drainage Mains	DC_DrainageMain_N.shp	Drainage Mains in the Northern part
	DC_DrainageMain_S.shp	Drainage Mains in the Southern part
	DC_DM_Section_N.shp	Drainage Main Sections in the Northern part
	DC_DM_Section_S.shp	Drainage Main Sections in the Southern part
	DC_DM_MTH_N. shp	Maintenance Hole for Drainage Main in the Northern part of Study Area
	DC_DM_MTH_S. shp	Maintenance Hole for Drainage Main in the Southern part of Study Area
	DC_DM_MTH_Link_N.shp	Maintenance hole link and culvert characteristic of drainage main in the Northern part of Study Area
	DC_DM_MTH_Link_S.shp	Maintenance hole link and culvert characteristic of drainage main in the Southern part of Study Area
Laterals	DC_Lateral.shp	Laterals in the Study Area
	DC_Connection_N.shp	Laterals to connect estero and estero, or estero and drainage main
	DC_Connection_S.shp	Laterals to connect estero and estero, or estero and drainage main
	DC_Manhole.shp	Manhole
Drainage Basins	DC_Block_N.shp	Drainage Block
	DC_Block_S.shp	Drainage Block
	DC_Basin_N.shp	Drainage Basins
	DC_Basin_S.shp	Drainage Basins
	DC_Reach_N.shp	Drainage Reach Basins
	DC_Reach_S.shp	Drainage Reach Basins
	DC_SubBasin_N.shp	Drainage Sub basins
	DC_SubBasin_S.shp	Drainage Sub basins
Probable Discharge	DC_ProbableDischarge_N.shp	Probable Peak Discharge of Specific Point
	DC_ProbableDischarge_S.shp	Probable Peak Discharge of Specific Point

WATER FACILITIES	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\WaterFacilities	
Pumping Stations	WC_PumpingSta_All.shp	Pumping Stations
	WC_PumpingSta_N.shp	Pumping Stations in the Northern part
	WC_PumpingSta_S.shp	Pumping Stations in the Southern part
	WC_PumpingSta_Major.shp	Large Pumpning Stations
	WC_PumpingSta_Small.shp	Small Pumping Stations
Water Gates	WC_ControlGate.shp	Control Gate
	WC_ControlWall.shp	Control Wall
	WC_IndependentFloodGate.shp	Independent Flood Gate

Table A.3.1 List of GIS Data (2/4)

	File Name	***Description***
Automatic Trash Screen	WC_TrashScreen_S.shp	Automatic Trash Screens in the Northern part

O & M	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\OperationMaintenance	
Operation and Maintenance	OC_OM_Zone.shp	Boundary for Operation & Maintenance

INUNDATION	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Inundation	
Actual Inundation Map In 1999 flood	IC_ActlnunDepth_N_1999.shp IC_ActlnunDepth_S_1999.shp IC_ActlnunDuration_N_1999.shp IC_ActlnunDuration_S_1999.shp	Inundation depth of 1999 flood Inundation depth of 1999 flood Inundation duration of 1999 flood Inundation duration of 1999 flood
	depth_n depth_s duration_n duration_s	Inundation depth of 1999 flood Inundation depth of 1999 flood Inundation duration of 1999 flood Inundation duration of 1999 flood
	IC_ActlnunPoint1999.shp	Inundation data of 1999 flood
	Intersection_building_depth_n.shp Intersection_building_depth_s.shp Intersection_building_duration_n.shp Intersection_building_duration_s.shp	Building Classification by inundation depth Building Classification by inundation depth Building Classification by inundation duration Building Classification by inundation duration
Actual Inundation Map In 2004 flood	IC_ActlnunDepth_N_2004.shp IC_ActlnunDepth_S_2004.shp IC_ActlnunDuration_N_2004.shp IC_ActlnunDuration_S_2004.shp	Inundation depth of 2004 flood Inundation depth of 2004 flood Inundation duration of 2004 flood Inundation duration of 2004 flood
	dep_n_2004 dep_s_2004 dur_n_2004 dur_s_2004	Inundation depth of 2004 flood Inundation depth of 2004 flood Inundation duration of 2004 flood Inundation duration of 2004 flood
	IC_ActlnunPoint2004	Inundation data of 2004 flood

NATURAL CONDITIONS	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\NaturalConditions	
Contours	NC_Contour.shp	Contours
Elevations	NC_BenchMark elevation elev_dpwh	Bench Mark for the Study Elevation grid map in Raster Format Elevation grid map in Raster Format
Slope	slope NC_Slope	Slope grid map in Raster Format Slope classification
Rivers	NC_Pasig_River_Centerline.shp NC_Pasig_River_Polygon.shp NC_PasigIsland.shp	Pasig River center line River Polyogn Islands in Pasig River
Reservoir/Pond	NC_ReservoirN.shp NC_ReservoirS.shp NC_Pond_S.shp	Reservoir or Pond in Northern part of Study Area Reservoir or Pond in Southern part of Study Area Pond in the Southern part of the Study area
Manila Bay	NC_ManilaBay.shp	Manila Bay

METEOHYDROLOGY	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Meteohydrology	
Meteorological Station	MC_MeteoSta.shp	Meterologigal Station in Metropolitan Manila
Water Level Station	MC_WLSta.shp	Water Level Station in Metropolitan Manila
Tide Level Station	MC_TideSta.shp	Tide Level Station in Metropolitan Manila
Thiessen Polyline	MC_Thiessen.shp	Thiessen Polyline

Table A.3.1 List of GIS Data (3/4)

	File Name	***Description***
WASTE MANAGEMENT	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\WasteManagement	
Waste Survey Point	WC_SurveyPoint.shp	Waste Survey Point

GEOLOGY	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Geology	
Geological Formations	G_Formation1.shp G_Formation2.shp	Geological Formations - Phivolcs Geological Formations - Oyo

ENVIRONMENT	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Environment	
Water Quality	EC_WaterQualiry.shp	Water Quality survey result
Sediment Quality	EC_SedimentQuality.shp	Sediment Quality survey result
Pollution Source	EC_PollutionSource.shp	Pollution source survey result

SOCIAL CONDITIONS	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\SocialConditions	
Barangay Boundaries	SC_BgyBnd.shp	Barangay Boundaries Edited Boundaries to match NSO Boundaries
City/Municipal Boundaries	S_CityBnd.shp S_CityBnd2003.shp	City/Municipal Boundaries City/Municipal Boundaries in 2003
EIS01 (Survey for Estero Informal Settlers along selected Esteros) Building	EIS01_Building.shp EIS01_Building_Clip.shp EIS01_DenseArea.shp EIS01_DenseArea_Clip.shp	Building along Estero de Sunog Apog and Tripa de Gallina Building within Estero de Sunog Apog and Tripa de Gallina Densely Buildup Area along Estero de Sunog Densely Buildup Area within Estero de Sunog
Reach	EIS01_Reach00.shp EIS01_Reach04.shp EIS01_Reach10.shp EIS01_Reach20.shp	Area of Water Body of Selected Esteros Area of 4m outside from Edge of Selected Esteros Area of 10m outside from Edge of Selected Esteros Area of 20m outside from Edge of Selected Esteros
Structure	EIS01_EmbankmentType.shp EIS01_Road.shp	Type of Embankment along Selected Esteros Roads along Selected Esteros
EIS02 (Survey for Estero Informal Settlers along Esteros except two)	EIS02_Building_SSHW.shp EIS02_DenseArea.shp EIS02_DenseArea_Clip.shp EIS02_EsteroReach.shp	Buildings along South Super Highway and Sen. Gil J. Puyat Avenue Densely Buildup Area along Esteros except Sunog Apog and Tripa de Gallina Densely Buildup Area within Esteros except Sunog Apog and Tripa de Gallina Area of Water Body of Esteros except Sunog Apog and Tripa de Gallina

SOCIO-ECONOMIC CONDITIONS	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\SocioEconomicConditions	
Land Price	SC_landprice.shp Landprice Landprice_n Landprice_s	Land price landprice grid map in Raster Format landprice grid map in Raster Format landprice grid map in Raster Format

LANDUSE	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Landuse	
Landuse	LC_Landuse_N.shp LC_Landuse_S.shp LC_Landuse_Per_SubBasin_N.shp LC_Landuse_Per_SubBasin_S.shp	Land Use of Northern Part of Study Area Land Use of Southern Part of Study Area Land Use per Sub Basin Land Use per Sub Basin

Table A.3.1 List of GIS Data (4/4)

	File Name	***Description***
BUILDING	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Building	
Building	BC_Building_Poly_N.shp BC_Building_Poly_S.shp BC_Building_Point_N.shp BC_Building_Point_S.shp	Polygon of Building Polygon of Building Center Point of Building Center Point of Building

INFRASTRUCTURE	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Infrastructure	
Roads	IC_RoadCenter.shp IC_RoadEdge.shp	Road Centerlines Road Edges
Railroads	IC_Railroads.shp	Railway Lines

2. Master Plan Planning

DRAINAGE SYSTEM	\DICAMM_Database\GIS_Data\Shape\MasterPlanPlanning\DrainageSystem	
Esteros/Creeks	DP_Estero_Section_Plan_N.shp DP_Estero_Section_Plan_S.shp DP_Estero_Plan_CS_N.shp DP_Estero_Plan_CS_S.shp	Estero Sections in the Northern part Estero Sections in the Southern part Cross Section Point of Esteros in the Northern part Cross Section Point of Esteros in the Northern part
Drainage Mains	DP_DM_Section_Plan_N.shp DP_DM_Section_Plan_S.shp	Drainage Main Sections in the Northern part Drainage Main Sections in the Southern part
Drainage Basins	DP_Block_Plan_N.shp DP_Block_Plan_S.shp DP_Basin_Plan_N.shp DP_Basin_Plan_S.shp DP_Reach_Plan_N.shp DP_Reach_Plan_S.shp DP_SubBasin_Plan_N.shp DP_SubBasin_Plan_S.shp	Drainage Block for Master Plan Drainage Blockfor Master Plan Drainage Basins for Master Plan Drainage Basins for Master Plan Drainage Reach Basins for Master Plan Drainage Reach Basins for Master Plan Drainage Sub basins for Master Plan Drainage Sub basins for Master Plan
Probable Discharge	DP_ProbableDischarge_N.shp DP_ProbableDischarge_S.shp	Probable Peak Discharge of Specific Point Probable Peak Discharge of Specific Point

3. Simulation

INUNDATION MAP	\DICAMM_Database\GIS_Data\Shape\Simulaiton\Inundation_Depth_Duration	
Simulated Inundation Map	n_a1_dep.shp n_a2_dep.shp ~ s_p2_dep.shp n_a1_dur2.shp n_a2_dur2.shp ~ s_p2_dur2.shp	Simulated Inundation Depth Map Simulated Inundation Depth Maps Simulated Inundation Duration Map Simulated Inundation Duration Maps

INPUT DATA	\DICAMM_Database\GIS_Data\Shape\Simulaiton\Input_Data	
Simulated Inundation Points	res_n_a1.shp res_n_a2.shp ~ res_s_p2.shp	Point Data of Simulated Inundation Result Point Data of Simulated Inundation Results
Elevation of Simulated Points	Flood_Input_Ele_N.shp Flood_Input_Ele_S.shp	Elevation of Points used to Inundation Calculation in the Northern Part Elevation of Points used to Inundation Calculation in the Southern Part

Table A.3.2 Detailed List of GIS Data (1/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
1. Exsitning Conditions												
BASE MAP	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\BaseMap											
Study Area	BC_StudyArea.shp	Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains study area of this study, which is the core area of Metropolitan Manila.	FID			
									SHAPE			
									AREA	Number	18	Total area of Study area in meter unit.
	BC_StudyArea_N.shp	Northern part of the Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains Northern part of the study area of this study.	FID			
									SHAPE			
									AREA	Number	18	Total area of Northern part of Study area in meter unit.
	BC_StudyArea_S.shp	Southern part of the Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains Southern part of the study area of this study.	FID			
									SHAPE			
									AREA	Number	18	Total area of Southern part of Study area in meter unit.
	BC_StudyArea_Buffer1km.shp	Buffer of Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains buffer for the study area in 1 kilometer distance	FID			
									Shape			
									Area	Number	17	in meter unit
									Comment	String	50	Bufer for the study area with 1km width
	BC_StudyArea_Mask.shp	Mask of Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile is just a frame used for the design of maps to cover other images	FID			
									Shape			
									Comment	String	50	Mask for the study area
	BC_StudyArea_Mask1km.shp	Mask of Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile is just a frame used for the design of maps to cover other images	FID			
									Shape			
									Comment	String	50	Mask for the study area with 1km width
DRAINAGE SYSTEM	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\DrainageSystem											
Esteros/Creeks	DC_Estero_N.shp	Esteros and Creeks in the Northern part	MMEIRS Map 1:5000 SEDLMM Map 1:2500	2003 2000	PTM III PTM III	Line	Arcview	This shapefile contains the centerline of esteros and creeks in the Northern part of the Study area. The original line was extracted from 2000 SEDLMM map and then edited based on the result of detailed field survey and investigation	FID			
									SHAPE			
									JICA_Code	String	254	Code for estero
									Length	Number	31	in meter unit
									N_Estero	String	254	Name for estero in the Northern part of the study area
									DetailInfo	String	150	Folder name that detailed information is put
	DC_Estero_S.shp	Esteros and Creeks in the Southern part	MMEIRS Map 1:5000 SEDLMM Map 1:2500	2003 2000	PTM III PTM III	Line	Arcview	This shapefile contains the centerline of esteros and creeks in the Southern part of the Study area. The original line was extracted from 2000 SEDLMM map and then edited based on the result of detailed field survey and investigation	FID			
									SHAPE			
									JICA_Code	String	254	Code for estero
									Length	Number	31	in meter unit
									S_Estero	String	254	Name for estero in the Southern part of the study area
									DetailInfo	String	150	Folder name that detailed information is put
	DC_Estero_Section_N.shp	Estero Sections in the Northern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains estero sections which are parts of extero diveded into several in the Northern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	Estero section code from DICAMM Study in 2004
									Estero_ID	String	10	DICA code of estero
									EsteroName	String	50	Name of estero
									Length	Number	19	Length of each section in meter unit
									Water_Area	String	10	Area of Water body (m2)
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel 1: The capacity is more than Q10 2: The capacity is Q10 - Q5 3: The capacity is Q5 - Q3 4: The capacity is Q3 - Q2 5: The capacity is less than Q2 6: Not specified
									Build_Area	String	10	Total building and dense area within channel (m2)
									PCTBldArea	String	10	Percentage of ("building area"/ "water area") (%)
									Num_Build	String	10	Estimated number of buidlings within channel
									N_Bld_1km	String	10	Estimated number of buidlings within channel per length (km-1)
	DC_Estero_Section_S.shp	Estero Sections in the Southern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains estero sections which are parts of extero diveded into several in the Southern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	Estero section code from DICAMM Study in 2004
									Estero_ID	String	10	DICA code of estero
									EsteroName	String	50	Name of estero
									Length_1	Number	19	Length of each section in meter unit
									Water_Area	String	10	Area of Water body (m2)
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel 1: The capacity is more than Q10 2: The capacity is Q10 - Q5 3: The capacity is Q5 - Q3 4: The capacity is Q3 - Q2 5: The capacity is less than Q2 6: Not specified
									Build_Area	String	10	Total building and dense area within channel (m2)
									PCTBldArea	String	10	Percentage of ("building area"/ "water area") (%)
									Num_Build	String	10	Estimated number of buidlings within channel
									N_Bld_1km	String	10	Estimated number of buidlings within channel per length (km-1)
	DC_Estero_Edge_N.shp	Estero Edges in the Northern part	MMEIRS aerial-photo 1:5,000	2003	PTM III	Line	Arcview	This shapefile contains the edge of esteros in the Northern part of the Study area extracted from 2003 MMEIRS JICA aerial-photgraph. The original file was edited based on the result of detailed field survey and investigation.	FID			
									SHAPE			
									Length	Number	19	In meter unit
	DC_Estero_Edge_S.shp	Estero Edges in the Southern part	MMEIRS aerial-photo 1:5,000	2003	PTM III	Line	Arcview	This shapefile contains the edge of esteros in the Southern part of the Study area extracted from 2003 MMEIRS JICA aerial-photgraph. The original file was edited based on the result of detailed field survey and investigation.	FID			
									SHAPE			
									Length	Number	19	in meter unit
	DC_Estero_Poly.shp	Polygon of Estero	MMEIRS aerial-photo 1:5,000	2003	PTM III	Polygon	Arcview	This shapefile contains the polygons of esteros in the Study area extracted from 2003 MMEIRS JICA aerial-photgraph. The original file was edited based on the result of detailed field survey and investigation.	FID			
									SHAPE			
									SecCode	String	10	New code for estero section
									Area	Number	11	in meter unit

Table A.3.2 Detailed List of GIS Data (2/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
	DC_Estero_CS_N.shp	Cross Section Point of Esteros in the Northern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains detailed information of cross section surveyed in 2000 SEDLMM and in 2004 DICA study in the Northern part of Study Area.	FID			
									SHAPE			
									DICA_Code	String	15	New code from DICAMM Study in 2004
									Estero_ID	String	254	DICA code of estero
									Station	String	254	name of station for estero cross section
									Study_Name	String	255	Study name that survey was conducted
									YearSurvey	Number	11	Surveyed year
									Xcoor_Post	Number	19	x-coordination of cross section post
									Ycoor_Post	Number	119	y-coordination of cross section post
									Elev_Post	Number	19	Elevation of Post
									Elev_Lbank	Number	19	Elevation of left bank elevation
									Elev_Rbank	Number	19	Elevation of right bank elevation
									Width	Number	19	Width of extero
									Ex_BedElev	Number	19	Existing river bed elevation
									DetailInfo	String	150	Folder name that detailed information is put (Note: "-999" means "no data")
	DC_Estero_CS_S.shp	Cross Section Point of Esteros in the Southern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains detailed information of cross section surveyed in 2000 SEDLMM and in 2004 DICA study in the Southern part of Study Area.	FID			
									SHAPE			
									DICA_Code	String	15	New code from DICAMM Study in 2004
									Estero_ID	String	254	DICA code of estero
									Station	String	254	name of station for estero cross section
									YearSurvey	Number	5	Surveyed year
									Study_Name	String	10	Study name that survey was conducted
									Xcoor_Post	Number	19	x-coordination of cross section post
									Ycoor_Post	Number	19	y-coordination of cross section post
									Elev_Post	Number	19	Elevation of Post
									Elev_Lbank	Number	19	Elevation of left bank elevation
									Elev_Rbank	Number	19	Elevation of right bank elevation
									Width	Number	19	Width of extero
									Ex_BedElev	Number	19	Existing river bed elevation
									DetailInfo	String	150	Folder name that detailed information is put (Note: "-999" means "no data")
Drainage Mains	DC_DrainageMain_N.shp	Drainage Mains in the Northern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains drainage mains in the Northern part of the Study area. The original line was extracted from 2000 SEDLMM map and then edited based on the result of detailed field survey and investigation	FID			
									Shape			
									JICA_Code	String	254	Code for drainage main
									Length	Number	31	in meter unit (Note: Length is measured from junction of extero center line to the end of drainage main)
									NAME	String	254	Name of drainage main
									DetailInfo	String	120	Folder name that detailed information is put
	DC_DrainageMain_S.shp	Drainage Mains in the Southern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains drainage mains in the Southern part of the Study area. The original line was extracted from 2000 SEDLMM map and then edited based on the result of detailed field survey and investigation	FID			
									Shape			
									JICA_Code	String	254	Code for drainage main
									Length	Number	31	in meter unit (Note: Length is measured from junction of extero center line to the end of drainage main)
									NAME	String	254	Name of drainage main
									DetailInfo	String	120	Folder name that detailed information is put
	DC_DM_Section_N.shp	Drainage Main Sections in the Northern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains drainage main sections which are parts of DM diveded into several in the Northern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	DM section code from DICAMM Study in 2004
									DM_ID	String	10	DICA code of drainage main
									DM_Name	String	50	Name of drainage main
									Length	Number	19	Length of each section in meter unit (Note: Length of 1st section is measured from junction of extero center line)
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel 1: The capacity is more than Q10 2: The capacity is Q10 - Q5 3: The capacity is Q5 - Q3 4: The capacity is Q3 - Q2 5: The capacity is less than Q2 6: Not specified
	DC_DM_Section_S.shp	Drainage Main Sections in the Southern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains drainage main sections which are parts of DM diveded into several in the Southern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	DM section code from DICAMM Study in 2004
									DM_ID	String	10	DICA code of drainage main
									DM_Name	String	50	Name of drainage main
									Length	Number	19	Length of each section in meter unit (Note: Length of 1st section is measured from junction of extero center line)
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel 1: The capacity is more than Q10 2: The capacity is Q10 - Q5 3: The capacity is Q5 - Q3 4: The capacity is Q3 - Q2 5: The capacity is less than Q2 6: Not specified
	DC_DM_MTH_N. shp	Maintenance Hole for Drainage Main in the Northern part of Study Area	JICA Study	2004	PTM III	Point	Arcview	This shape file contains maintenance hole data along drainage main. In the Northern part of Study Area	FID			
									Shape			
									DM_Code	String	10	ID for drainage main
									MTH_Code	String	15	ID for Maintenance hole from DICA Study
									X_COORD	Number	19	X-coordination of maintenance hole
									Y_COORD	Number	19	Y-coordination of maintenance hole
									DICA_GE	Number	19	Ground elevation for DICA 2004 study (m)
									EleDICAMSL	Number	19	Ground elevation by MSL for DICA 2004 study (m)
									MH_Dpe	Number	19	MTH bed elevation with sediment (m)
									MH_ID_2000	String	15	ID for MTH from 2000 SEDLMM
									The following data are from SEDLMM database			
									HouseLot	String	50	Nearest house lot no.
									Street	String	50	Street

Table A.3.2 Detailed List of GIS Data (3/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									Barangay	String	20	Barangay code
									City	String	20	City
									ManDia	String	10	Manhole diameter (mm)
									ManLen	String	10	Manhole length (mm)
									ManWid	String	10	Manhole width (mm)
									ManThick	String	10	Manhole thickness (mm)
									ManDep	String	10	Manhole depth (mm)
									ManCovPcs	String	10	Number of manhole cover
									ManCovDia	String	10	Diameter of manhole cover (mm)
									ManCovLen	Number	19	Length of manhole cover (mm)
									ManCovWid	Number	19	Width of manhole cover (mm)
									ManCovThick	String	10	Thickness of manhole cover (mm)
									ManCrack	String	10	With manhole crack? (Y for Yes, N for No)
									WaSurface	Number	19	Distance of water surface from top of manhole cover top of manhole cover
									WaCon	String	10	Water condition (N for Normal, S for Stagnant water)
									DepSurf	Number	19	Distance of deposition surface from top of manhole cover top of manhole cover
									DepMat	String	20	Deposited materials
									Obs	String	15	With obstacles?
									CurbInl	String	10	With curb inlet? (Y for Yes, N for No)
									CurbInlWid	String	10	Curb inlet width (mm)
									CurbInlHei	String	10	Curb inlet height (mm)
									ManTopElev	Number	19	Manhole top elevation (m)
									DBCode	String	10	Drainage block code
									BMCode	String	10	Bench mark code used
									DrEngr	String	15	Name of Drainage engineer
									Checker	String	10	Checker of datasheet
									DateInput	Date	8	Date of input
									Operator	String	10	Name of computer encoder/operator
									Remarks	String	10	Remarks
									MapPrefix	String	10	Prefix of map code for SEDLMM drainage map
									Agency	String	10	Agency or Consultant Name
									DetailInfo	String	120	Folder name that detailed information is put
	DC_DM_MTH_S. shp	Maintenance Hole for Drainage Main in the Southern part of Study Area	JICA Study	2004	PTM III	Point	Arcview	This shape file contains maintenance hole data along drainage main. in the Southern part of Study Area	FID			
									Shape			
									DM_Code	String	10	ID for drainage main
									MTH_Code	String	15	ID for Maintenance hole from DICA Study
									X_COORD	Number	19	X-coordination of maintenance hole
									Y_COORD	Number	19	Y-coordination of maintenance hole
									DICA_GE	Number	19	Ground elevation for DICA 2004 study (m)
									EleDICAMSL	Number	19	Ground elevation by MSL for DICA 2004 study (m)
									MH_Dpe	Number	19	MTH bed elevation with sediment (m)
									MH_ID_2000	String	15	ID for MTH from 2000 SEDLMM
									The following data are from SEDLMM database			
									HouseLot	String	50	Nearest house lot no.
									Street	String	50	Street
									Barangay	String	20	Barangay code
									City	String	20	City
									ManDia	String	10	Manhole diameter (mm)
									ManLen	String	10	Manhole length (mm)
									ManWid	String	10	Manhole width (mm)
									ManThick	String	10	Manhole thickness (mm)
									ManDep	String	10	Manhole depth (mm)
									ManCovPcs	String	10	Number of manhole cover
									ManCovDia	String	10	Diameter of manhole cover (mm)
									ManCovLen	Number	19	Length of manhole cover (mm)
									ManCovWid	Number	19	Width of manhole cover (mm)
									ManCovThick	String	10	Thickness of manhole cover (mm)
									ManCrack	String	10	With manhole crack? (Y for Yes, N for No)
									WaSurface	Number	19	Distance of water surface from top of manhole cover top of manhole cover
									WaCon	String	10	Water condition (N for Normal, S for Stagnant water)
									DepSurf	Number	19	Distance of deposition surface from top of manhole cover top of manhole cover
									DepMat	String	20	Deposited materials
									Obs	String	15	With obstacles?
									CurbInl	String	10	With curb inlet? (Y for Yes, N for No)
									CurbInlWid	String	10	Curb inlet width (mm)
									CurbInlHei	String	10	Curb inlet height (mm)
									ManTopElev	Number	19	Manhole top elevation (m)
									DBCode	String	10	Drainage block code
									BMCode	String	10	Bench mark code used
									DrEngr	String	15	Name of Drainage engineer
									Checker	String	10	Checker of datasheet
									DateInput	Date	8	Date of input
									Operator	String	10	Name of computer encoder/operator
									Remarks	String	10	Remarks
									MapPrefix	String	10	Prefix of map code for SEDLMM drainage map
									Agency	String	10	Agency or Consultant Name
									DetailInfo	String	120	Folder name that detailed information is put
	DC_DM_MTH_Link_N.shp	Maintenance hole link and culvert characteristic of drainage main in the Northern part of Study Area	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains link of maintenance holes and culvert characteristic for drainage mains in the Northern part of Study Area	FID			
									Shape			
									DM_Code	String	10	ID for drainage main
									MTH_L_Code	String	15	ID for link of Maintenance hole from DICA Study
									MTH_Down	String	15	MTH code of the downstream side of link/culvert
									MTH_Up	String	15	MTH code of the upstream side of link/culvert
									Length	Number	19	in meter unit
									DC_IE	Number	19	Invert elevation of culvert in the downstream side
									DC_TE	Number	19	Top elevation of culvert in the downstream side
									DC_NC	String	254	Number of culvert in the downstream side
									DC_TYP	String	254	Type of culvert in the downstream side (B: Box, P:Pipe)
									DC_WID	Number	19	Width of culvert in the downstream side
									DC_DEP	Number	19	Height or diameter of culvert in the downstream side
									UC_IE	Number	19	Invert elevation of culvert in the upstream side
									UC_TE	Number	19	Top elevation of culvert in the upstream side

Table A.3.2 Detailed List of GIS Data (4/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									UC_NC	String	254	Number of culvert in the upstream side
									UC_TYP	String	254	Type of culvert in the upstream side (B: Box, P:Pipe)
									UC_WID	Number	19	Width of culvert in the upstream side
									UC_DEP	Number	19	Height or diameter of culvert in the upstream side
	DC_DM_MTH_Link_S.shp	Maintenance hole link and culvert characteristic of drainage main in the Southern part of Study Area	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains link of maintenance holes and culvert characteristic for drainage mains in the Southern part of Study Area	FID			
									Shape			
									DM_Code	String	10	ID for drainage main
									MTH_L_Code	String	15	ID for link of Maintenance hole from DICA Study
									MTH_Down	String	15	MTH code of the downstream side of link/culvert
									MTH_Up	String	15	MTH code of the upstream side of link/culvert
									Length	Number	19	in meter unit
									DC_IE	Number	19	Invert elevation of culvert in the downstream side
									DC_TE	Number	19	Top elevation of culvert in the downstream side
									DC_NC	String	254	Number of culvert in the downstream side
									DC_TYP	String	254	Type of culvert in the downstream side (B: Box, P:Pipe)
									DC_WID	Number	19	Width of culvert in the downstream side
									DC_DEP	Number	19	Height or diameter of culvert in the downstream side
									UC_IE	Number	19	Invert elevation of culvert in the upstream side
									UC_TE	Number	19	Top elevation of culvert in the upstream side
									UC_NC	String	254	Number of culvert in the upstream side
									UC_TYP	String	254	Type of culvert in the upstream side (B: Box, P:Pipe)
									UC_WID	Number	19	Width of culvert in the upstream side
									UC_DEP	Number	19	Height or diameter of culvert in the upstream side
Laterals	DC_Lateral.shp	Laterals in the Study Area	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains lateral lines and lateral/culvert characteristic. The original line was extracted from 2000 SEDLMM map and then edited.	FID			
									SHAPE			
									Lateral_ID	String	15	ID for link of Manholes from DICA Study
									Length	Number	9	in meter unit
									MH_Down	String	15	Manhole code of the downstream side of link/culvert
									MH_Up	String	15	Manhole code of the upstream side of link/culvert
									DownStatus	String	1	Condition of channel (N if normal, C if Clogged)
									Down_mat	String	10	Composition/made of channel (C for concrete, S for steel, P for Pvc, M for masonry, R for riprap)
									Down_shp	String	5	Shape of channel (R for rectangle, C for circular, T for trapezoidal)
									Dn_dia_wid	Number	4	Diameter if Circular or top width if Rectangular or Trapezoidal (mm)
									Down_dep	Number	4	Channel depth for Rectangular and Trapezoidal only (mm)
									Dn_bot_wid	Number	4	Bottom width (mm). Applicable only in Trapezoidal
									Down_cell	Number	4	Number of cells
									Down_bot	Number	4	Distance of invert from top of manhole cover (mm)
									Down_ovb	Number	4	Distance of top of channel from top of manhole cover (mm)
									Up_status	String	1	Condition of channel (N if normal, C if Clogged)
									Up_mat	String	10	Composition/made of channel (C for concrete, S for steel, P for Pvc, M for masonry, R for riprap)
									Up_shp	String	5	Shape of channel (R for rectangle, C for circular, T for trapezoidal)
									Up_dia_wid	Number	4	Diameter if Circular or top width if Rectangular or Trapezoidal (mm)
									Up_dep	Number	4	Channel depth for Rectangular and Trapezoidal only (mm)
									Up_bot_wid	Number	4	Bottom width (mm). Applicable only in Trapezoidal
									Up_cell	Number	4	Number of cells
									Up_bot	Number	4	Distance of invert from top of manhole cover (mm)
									Up_ovb	Number	4	Distance of top of channel from top of manhole cover (mm)
	DC_Connection_N.shp	Laterals to connect estero and estero, or estero and drainage main	JICA Study Survey Map	2004	PTM III	Line	Arcview	This shapefile contains laterals to connect estero and estero, or estero and drainage main in Northern part of the Study Area.	FID			
									Shape			
									DICA_Code	String	10	ID for connection
									Length	Number	11	in meter unit
									Conection	String	20	Connection of waterways
	DC_Connection_S.shp	Laterals to connect estero and estero, or estero and drainage main	JICA Study Survey Map	2004	PTM III	Line	Arcview	This shapefile contains laterals to connect estero and estero, or estero and drainage main in Southern part of the Study Area.	FID			
									Shape	String		
									DICA_Code	String	10	ID for connection
									Length	Number	11	in meter unit
									Conection	String	20	Connection of waterways
	DC_Manhole.shp	Manhole	SEDLMM Map 1:2500 Access data of SEDLMM	2000 2000	PTM III	Point	Arcview	This shape file contains manhole location and various manhole data	FID			
									SHAPE			
									ID	String	10	ID for manfole from 2004 DICA Study
									MH_CODE	String	15	Manhole code from 2000 SEDLMM
									X_COORD	Number	19	X-coordination of manhole
									Y_COORD	Number	19	Y-coordination of manhole
									DICA_GE	Number	19	Ground elevation by DPWH Datum for DICA 2004 study (m) Figure of "0" means "no data."
									EleDICAMSL	Number	19	Ground elevation by MSL for DICA 2004 study (m)
									The following data are from SEDLMM database			
									HouseLot	String	50	Nearest house lot no.
									Street	String	100	Street
									Barangay	String	100	Barangay code
									City	String	20	City
									ManDia	Number	4	Manhole diameter (mm)
									ManLen	Number	4	Manhole length (mm)
									ManWid	Number	4	Manhole width (mm)
									ManThick	Number	4	Manhole thickness (mm)
									ManDep	Number	4	Manhole depth (mm)
									ManCovPcs	Number	4	Number of manhole cover
									ManCovDia	Number	4	Diameter of manhole cover (mm)
									ManCovLen	Number	4	Length of manhole cover (mm)
									ManCovWid	Number	4	Width of manhole cover (mm)
									ManCovThick	Number	4	Thickness of manhole cover (mm)
									ManCrack	String	1	With manhole crack? (Y for Yes, N for No)

Table A.3.2 Detailed List of GIS Data (5/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									WaSurface	Number	4	Distance of water surface from top of manhole cover top of manhole cover
									WaCon	String	1	Water condition (N for Normal, S for Stagnant water)
									DepMat	String	20	Deposited materials
									Obs	String	20	With obstacles?
									CurbInl	String	1	With curb inlet? (Y for Yes, N for No)
									CurbInlWid	Number	4	Curb inlet width (mm)
									CurbInlHei	Number	4	Curb inlet height (mm)
									DBCode	String	10	Drainage block code
									ManTopElev	Number	19	Manhole top elevation (m)
									BMCode	String	20	Bench mark code used
									DrEngr	String	50	Name of Drainage engineer
									Checker	String	50	Checker of datasheet
									DateTimeIn	Date	8	Date of investigation
									DateInput	Date	8	Date of input
									Operator	String	50	Name of computer encoder/operator
									Remarks	String	50	Remarks
									Agency	String	12	Agency or Consultant Name
									DepSurf	Number	4	Distance of deposition surface from top of manhole cover
Drainage Basins	DC_Block_N.shp	Drainage Block	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage block of future plan that includes several drainage area for pumping station and gravity drainage area in the Northern part of the Study Area.	FID			
									SHAPE			
									BLOCK_ID	String	254	ID for drainage block
									Block_Name	String	50	Name of drainage block
									Area	Number	17	in meter unit
									RO_Coeff	Number	13	Runoff coefficient
	DC_Block_S.shp	Drainage Block	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage block that includes several drainage area for pumping station and gravity drainage area in the Southern part of the Study Area.	FID			
									SHAPE			
									BLOCK_ID	String	254	ID for drainage block
									Block_Name	String	50	Name of drainage block
									Area	Number	17	in meter unit
									RO_Coeff	Number	13	Runoff coefficient
	DC_Basin_N.shp	Drainage Basins	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage area that is divided by baically based upon the previous plan for pumping drainage area, but modified based upon the information on existing laterals, and shows relation of each basins in the Northern part of the Study Area..	FID			
									Shape			
									BASIN_ID	String	254	ID for drainage basins
									Basin_Name	String	50	Name of drainage basin
									Area	Number	17	in meter unit
									RO_Coeff	Number	13	Runoff coefficient
									Drain_Sys	String	10	Drainage system
	DC_Basin_S.shp	Drainage Basins	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage area that is divided by baically based upon the previous plan for pumping drainage area, but modified based upon the information on existing laterals, and shows relation of each basins in the Southern part of the Study Area..	FID			
									Shape			
									BASIN_ID	String	254	ID for drainage basins
									Basin_Name	String	50	Name of drainage basin
									Area	Number	17	in meter unit
									RO_Coeff	Number	13	Runoff coefficient
									Drain_Sys	String	10	Drainage system
	DC_Reach_N.shp	Drainage Reach Basins	JICA Study	2004	PTM III	Polygon	Arcview	This Shapefile contains associated sub basins to estimate probable peak discharge at several observation points and to give run-off in conducting hydraulic simulation by MOUSE in the Northern part of Study Area.	FID			
									SHAPE			
									REACH_ID	String	254	ID for reach basin
									Area	Number	19	in meter unit
									RO_Coeff	Number	11	Runoff coefficient
	DC_Reach_S.shp	Drainage Reach Basins	JICA Study	2004	PTM III	Polygon	Arcview	This Shapefile contains associated sub basins to estimate probable peak discharge at several observation points and to give run-off in conducting hydraulic simulation by MOUSE in the Southern part of Study Area.	FID			
									SHAPE			
									REACH_ID	String	254	ID for reach basin
									Area	Number	19	in meter unit
									RO_Coeff	Number	11	Runoff coefficient
	DC_SubBasin_N.shp	Drainage Sub basins	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains sub divided drainage area according to the information on existing laterals in the Northern part of Study Area.	FID			
									SHAPE			
									SubBasinID	String	10	ID for sub basin
									Mean_Slope	Number	19	Mean slope of sub basin (%)
									Mini_Elev	Number	19	Minimum elevation of sub basin in DPWH datum (m)
									Mean_Elev	Number	19	Mean elevation of sub basin in DPWH datum (m)
									Max_Elev	Number	19	Maximum elevation of sub basin in DPWH datum (m)
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									WATERWAY	String	16	ID of basin along same estero or drainage main
									BASIN_ID	String	10	ID of drainage basin
									BLOCK_ID	String	10	ID of drainage block
									REACH_ID	String	10	ID of reach basin
	DC_SubBasin_S.shp	Drainage Sub basins	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains sub divided drainage area according to the information on existing laterals in the Southern part of Study Area.	FID			
									SHAPE			
									SubBasinID	String	10	ID for sub basin
									Mean_Slope	Number	19	Mean slope of sub basin (%)
									Mini_Elev	Number	19	Minimum elevation of sub basin in DPWH datum (m)
									Mean_Elev	Number	19	Mean elevation of sub basin in DPWH datum (m)
									Max_Elev	Number	19	Maximum elevation of sub basin in DPWH datum (m)
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									WATERWAY	String	16	ID of basin along same estero or drainage main
									BASIN_ID	String	10	ID of drainage basin
									BLOCK_ID	String	10	ID of drainage block
									REACH_ID	String	10	ID of reach basin
Probable Discharge	DC_ProbableDischarge_N.shp	Probable Peak Discharge of Specific Point	JICA Study	2004	PTM III	Point	Arcview	This shape file contains probable peak discharge of specific point in the Northern part of the Study Area.	FID			
									SHAPE			
									Block_ID	String	10	ID of drainage block
									Basin_ID	String	10	ID of drainage basin
									WaterWayID	String	10	ID of waterway
									Reach_ID	String	10	ID of reach basin
									Drain_Area	Number	19	Drainage area (km2)
									RO_Coeff	Number	19	Runoff coefficient

Table A.3.2 Detailed List of GIS Data (6/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									Time_Conce	Number	19	Time of Concentration Tc (hour)
									Factor_Red	Number	19	Areal reduction factor
									Q10	Number	19	Q10 (m3/s)
									Q5	Number	19	Q5 (m3/s)
									Q3	Number	19	Q3 (m3/s)
									Q2	Number	19	Q2(m3/s)
									Remarks	String	20	Remarks
	DC_ProbableDischarge_S.shp	Probable Peak Discharge of Specific Point	JICA Study	2004	PTM III	Point	Arcview	This shape file contains probable peak discharge of specific point in the Southern part of the Study Area.	FID			
									SHAPE			
									Block_ID	String	10	ID of drainage block
									Basin_ID	String	10	ID of drainage basin
									WaterWayID	String	10	ID of waterway
									Reach_ID	String	10	ID of reach basin
									Drain_Area	Number	19	Drainage area (km2)
									RO_Coeff	Number	19	Runoff coefficient
									Time_Conce	Number	19	Time of Concentration Tc (hour)
									Factor_Red	Number	19	Areal reduction factor
									Q10	Number	19	Q10 (m3/s)
									Q5	Number	19	Q5 (m3/s)
									Q3	Number	19	Q3 (m3/s)
									Q2	Number	19	Q2(m3/s)
									Remarks	String	20	Remarks
WATER FACILITIES	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\WaterFacilities											
Pumping Stations	WC_PumpingSta_All.shp	Pumping Stations	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations and names of all the pumping stations in the Study Area..	FID			
									SHAPE			
									DPWHCode	String	50	Code for each pumping stations
									PSName	String	50	Name of Pumping Stations
									NewCode	String	50	New code from DICAMM project
	WC_PumpingSta_N.shp	Pumping Stations in the Northern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations and names of all the pumping stations in the Northern part of the Study area.	FID			
									SHAPE			
									DPWHCode	String	50	Code for each pumping stations
									PSName	String	50	Name of Pumping Stations
									NewCode	String	50	New code from DICAMM project
	WC_PumpingSta_S.shp	Pumping Stations in the Southern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations and names of all the pumping stations in the Southern part of the Study area.	FID			
									SHAPE			
									DPWHCode	String	50	Code for each pumping stations
									PSName	String	50	Name of Pumping Stations
									NewCode	String	50	New code from DICAMM project
	WC_PumpingSta_Major.shp	Large Pumpning Stations	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations, existing conditions and O&M conditions of all large pumping stations in the Study Area.	FID			
									Shape			
									DPWH_Code	String	50	Code for each pumping stations by DPWH
									PSName	String	50	Name of Pumping Stations
									DICA_Code	String	11	New code from DICAMM project
									Location	String	19	Location of pumping station
									DICADrArea	Number	19	Drainage area from 2004 DICA study (km2)
									ActPumpCap	Number	15	Actual total pump capacity (m3/s)
									YrConStart	Number	15	Year that construction stated
									YrConComp	Number	14	Year that construction completed
									FundSource	String	48	Fund source
									Civil_Cost	Number	19	Civil works cost (Ps)
									Equip_Cost	Number	19	Equipment cost (Ps)
									Total_Cost	Number	19	Total project cost (Ps)
									IniDrArea	Number	19	Drainage area (ha) in initial plan
									IniROCoe	Number	19	Run-off coefecient in initial plan
									IniConTime	Number	19	Concentration time (min.) in initial plan
									IniLenESTE	Number	19	Length of estero served (m) in initial plan
									IniLenCond	Number	19	Length of conduit served (m) in initial plan
									IniAveW_ES	Number	19	Average width of estero (m) in initial plan
									PPStartWL	Number	19	Pump start W.L (m)
									PPStopWL	Number	19	Pump stop W.L (m)
									Revet_Elev	Number	19	Top elevation of revetment at P/S (m)
									BottomEle	Number	17	Invert elevation (m)
									MainPPCapa	Number	16	Total pump capacity of main pump (m3/s)
									MainPPNum	String	14	Numbers of main pump unit (m3/s x no.)
									TotalMPPHd	Number	19	Total pump Head of main pump (m)
									MainPPType	String	35	Type of main pump
									DiaMPPBore	Number	19	Diameter of pump bore of main pump (mm)
									MainPP_BHP	Number	19	Brake Horse Power (hp)
									YrRehabili	Number	17	Year that rehabiltation was conducted
									Gate_W_H	String	11	Width (m) x Height (m) of gate
									Gate_Num	Number	19	Numbers of gate (no.)
									Gen_EngNum	Number	15	Total No. of units of Generator/Engine
									G_E_Capa	String	10	Capacity (KVA) of Generator/Engine
									G_E_BHP	String	10	Brake Horse Power (hp)
									YrAddPP	String	18	Construction year of Added Pump Equipment
									AddPPCapa	String	12	Total pump capacity (m3/s) of added pump
									AddPPNum	String	18	Numbers of added pump unit (m3/s x no.)
									AddPPType	String	14	Type of added pump
									DiaAPPBore	String	24	Diameter of pump bore of added pump (mm)
									Detailinfo	String	150	Folder name that detailed information is put (Note: "-999" or "-" means "no data")
	WC_PumpingSta_Small.shp	Small Pumping Stations	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations, existing conditions and O&M conditions of all small pumping stations in the Study Area.	FID			
									Shape			
									PS_Name	String	50	Total minor pumping stations
									JICA_Code	String	10	New code from DICAMM project
									Capacity	Number	11	Capacity of PS in m3/s
									Detailinfo	String	150	Folder name that detailed information is put
Water Gates	WC_ControlGate.shp	Control Gate	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains location of control gates.	FID			
									SHAPE			
									JICA_Code	String	10	New code from DICAMM project

Table A.3.2 Detailed List of GIS Data (7/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
	WC_ControlWall.shp	Control Wall	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains location of control walls.	FID			
									SHAPE			
									JICA_Code	String	10	New code from DICAMM project
	WC_IndependentFloodGate.shp	Independent Flood Gate	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains location of independent flood gates.	FID			
									SHAPE			
									JICA_Code	String	10	New code from DICAMM project
									Name	String	15	Name of independent flood gates
									Dimensions	String	50	Dimensions of flood gates
Automatic Trash Screen	WC_TrashScreen_S.shp	Automatic Trash Screens in the Northern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains location of automatic trash screens in the Southern part of the Study area.	FID			
									SHAPE			
									JICA_CODE	String	10	New Code for trash screens
									NAME	String	30	Name for trash screen south
O & M	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\OperationMaintenance											
Operation and Maintenance	OC_OM_Zone.shp	Boundary for Operation & Maintenance	MMDA	2004	PTM III	Polygon	Arcview	This shapefile contains boundary for Operation & Maintenance. The original data was provided by MMDA.	FID			
									SHAPE			
									DICA_Code	String	254	New code from DICAMM project
									Zone_Name	String	40	Name of O&M zone
									Equip_Info	String	50	Folder name that detailed information of equipments for O&M is put
INUNDATION	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Inundation											
Actual Inundation Map in 1999 flood	IC_ActInunDepth_N_1999.shp	Inundation depth of 1999 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundated area classified by inundation depth in Northern part of Study Area. This was calculated based on point data of maximum inundation depth of 1999 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Depth	String	15	Inundation depth in meter
									Area	Number	17	Inundation area in meter unit
	IC_ActInunDepth_S_1999.shp	Inundation depth of 1999 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundated area classified by inundation depth in Southern part of Study Area. This was calculated based on point data of maximum inundation depth of 1999 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Depth	String	15	Inundation depth in meter
									Area	Number	17	Inundation area in meter unit
	IC_ActInunDuration_N_1999.shp	Inundation duration of 1999 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundated area classified by inundation duration in Northern part of Study Area. . This classified inundated area is only area with inundation depth of more than 0.2 meter. This was calculated based on point data of inundation duration of 1999 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Duration	String	15	Inundation duration in hour
									Area	Number	17	Inundation area in meter unit
	IC_ActInunDuration_S_1999.shp	Inundation duration of 1999 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundation area classified by inundation duration in Southern part of Study Area. This classified inundated area is only area with inundation depth of more than 0.2 meter. This was calculated based on point data of inundation duration of 1999 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Duration	String	15	Inundation duration in hour
									Area	Number	17	Inundation area in meter unit
	depth_n	Inundation depth of 1999 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation depth of 1999 in Raster format in the Northern part of Study Area.				
	depth_s	Inundation depth of 1999 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation depth of 1999 in Raster format in the Southern part of Study Area.				
	duration_n	Inundation duration of 1999 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation duration in 1999 flood in Raster format in the Northern part of Study Area.				
	duration_s	Inundation duration of 1999 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation duration in 1999 flood in Raster format in the Southern part of Study Area.				
	IC_ActInunPoint1999.shp	Inundation data of 1999 flood	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains inundation data of 2000 SEDLMM. Inundation depth, duration and other data was surveyed in the 2000 SEDLMM Study. In careful comparison with original CAD drawing and table data (EXCEL data) including detailed data of survey points, survey points of CAD data are modified in this Study.	FID			
									SHAPE			
									JICA_CODE	Number	5	JICA Study code in 2004
									2000_ID	String	8	SEDLMM study code in 2000
									MAXDEPTH_M	Number	19	Maximum inundation depth in meter unit
									DURATION_H	Number	19	Inundation duration in hours
									CITY	String	50	City name
									DISTRICT	String	50	District name
									STREET	String	50	Street name
									OVERBANK	String	30	Overflowed drainage name
									REA_DRASYS	String	30	Drainage problem that caused inundation
									REA_OTHERS	String	40	Other reason that caused inundation
									FLOODFREYR	Number	19	Frequency of inundation per year
									SURVEYDATE	String	8	Surveyed date
	Intersection_building_depth_n.shp	Building Classification by inundation depth	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains bulding classificated by inundation depth in the Northern part of Study Area.	FID			
									SHAPE			
									HANDLE	String	16	ID of building
									CODE	Number	19	Code of depth
									DEPTH	String	15	Inundation depth in meter
	Intersection_building_depth_s.shp	Building Classification by inundation depth	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains bulding classificated by inundation depth in the Southern part of Study Area.	FID			
									SHAPE			
									HANDLE	String	16	ID of building
									CODE	Number	19	Code of depth
									DEPTH	String	15	Inundation depth in meter
	Intersection_building _duration_n.shp	Building Classification by inundation duration	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains bulding classificated by inundation duration in the Northern part of Study Area.	FID			
									SHAPE			
									HANDLE	String	16	ID of building
									CODE	Number	19	Code of duration
									DURATION	String	15	Inundation duration in hour
	Intersection_building _duration_s.shp	Building Classification by inundation duration	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains bulding classificated by inundation duration in the Southern part of Study Area.	FID			
									SHAPE			
									HANDLE	String	16	ID of building
									CODE	Number	19	Code of duration

Table A.3.2 Detailed List of GIS Data (8/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute			
									Name	Type	Width	Definition
									DURATION	String	15	Inundation duration in hour
Actual Inundation Map in 2004 flood	IC_ActInunDepth_N_2004.shp	Inundation depth of 2004 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundated area classified by inundation depth in Northern part of Study Area. This was calculated based on point data of maximum inundation depth of 2004 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Depth	String	15	Inundation depth in meter
									Area	Number	17	Inundation area in meter unit
	IC_ActInunDepth_S_2004.shp	Inundation depth of 2004 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundated area classified by inundation depth in Southern part of Study Area. This was calculated based on point data of maximum inundation depth of 2004 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Depth	String	15	Inundation depth in meter
									Area	Number	17	Inundation area in meter unit
	IC_ActInunDuration_N_2004.shp	Inundation duration of 2004 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundated area classified by inundation duration in Northern part of Study Area. This was calculated based on point data of inundation duration of 2004 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Duration	String	15	Inundation duration in hour
									Area	Number	17	Inundation area in meter unit
	IC_ActInunDuration_S_2004.shp	Inundation duration of 2004 flood	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains inundation area classified by inundation duration in Southern part of Study Area. This was calculated based on point data of inundation duration of 2004 flood	FID			
									SHAPE			
									DICA_CODE	Number	10	JICA Study code in 2004
									Duration	String	15	Inundation duration in hour
									Area	Number	17	Inundation area in meter unit
	dep_n_2004	Inundation depth of 2004 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation depth of 2004 in Raster format in the Northern part of Study Area.				
	dep_s_2004	Inundation depth of 2004 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation depth of 2004 in Raster format in the Southern part of Study Area.				
	dur_n_2004	Inundation duration of 2004 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation duration in 2004 flood in Raster format in the Northern part of Study Area.				
	dur_s_2004	Inundation duration of 2004 flood	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid inundation duration in 2004 flood in Raster format in the Southern part of Study Area.				
	IC_ActInunPoint2004	Inundation data of 2004 flood	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains inundation data of 2004 flood. Inundation depth, duration and other data was surveyed through JICA Study in 2004.	FID			
									SHAPE			
									CODE	Number	8	JICA Study code in 2004
									X	Number	16	x-coordination in PTM III
									Y	Number	16	y-coordination in PTM III
									MAXDEPTH	Number	11	Maximum inundation depth in meter unit
									DURATION	Number	8	Inundation duration in hours
									LOCATION	String	45	Description of location
									TimeFdRise	String	11	Time for Flood to Rise (hrs)
									TimeFdSlip	String	10	Time for Flood to Recede (hrs)
									Cause	String	47	Possible cause(s) of flooding
									SurveyDate	Date	8	Survey date
NATURAL CONDITIONS	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\NaturalConditions											
Contours	NC_Contour.shp	Contours	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains contours. It was made in combination with contours extracted from MMEIRS 2003 1:5000 base map and manhole top elevation revised based on	FID			
									SHAPE			
									LAYER	String	254	"CONT-MJR" and "CONT-MNR" are from SEDLMM
									ELE_MSL	Number	11	Elevation in meters based on MSL.
									DPWHDATUM	Number	16	Elevation in meters based on DPWH Datum.
Elevations	NC_BenchMark	Bench Mark for the Study	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains location and elevation of bench mark for JICA Study.	FID			
									SHAPE			
									BM	String	20	
									MSL	Number	11	Elevation in meters based on MSL.
									DPWH_Datum	Number	11	Elevation in meters based on DPWH Datum.
	elevation	Elevation grid map in Raster Format	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid elevations based on MSL in raster format.				
	elev_dpwh	Elevation grid map in Raster Format	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains grid elevations based on DPWH datum in raster format.				
Slope	slope	Slope grid map in Raster Format	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains slope values in raster format.				
	NC_Slope	Slope classification	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains slope classification.	FID			
									SHAPE			
									SlopeCode	String	10	Slope classification
									Slope	String	20	Explanation of slope classification
Rivers	NC_Pasig_River_Centerline.shp	Pasig River center line	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains a center line of Pasig River.	FID			
									SHAPE			
									PASIG_R_ID	Number	5	
	NC_Pasig_River_Polygon.shp	River Polyogn	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains a polygon of Pasig River.	FID			
									SHAPE			
									ID	Number	11	
									AREA	Number	31	in meter unit
									PERIMETER	Number	31	in meter unit
	NC_PasigIsland.shp	Islands in Pasig River	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains islands in Pasig River.	FID			
									SHAPE			
									NC_PASI_ID	Number	5	
									AREA	Number	15	in meter unit
Reservoir/Pond	NC_ReservoirN.shp	Reservoir or Pond in Northern part of Study Area	MMEIRS Map 1:5000	2003	PTM III	Polygon	Arcview	This shapefile contains reservoir of Northern study area, which extracted from year 2003 MMEIRS JICA map.	FID			
									SHAPE			
									ID	String	6	New Code from DICAMM project
	NC_ReservoirS.shp	Reservoir or Pond in Southern part of Study Area	MMEIRS Map 1:5000	2003	PTM III	Polygon	Arcview	This shapefile contains reservoir of Northern study area, which extracted from year 2003 MMEIRS JICA map.	FID			
									SHAPE			

Table A.3.2 Detailed List of GIS Data (9/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									ID	String	6	New Code from DICAMM project
	NC_Pond_S.shp	Pond in the Southern part of the Study area	MMEIRS Map 1:5000	2003	PTM III	Polygon	Arcview	This shapefile contains the only pond in the Southern part of the Study Area	FID			
									SHAPE			
									ID	String	6	New Code from DICAMM project
Manila Bay	NC_ManilaBay.shp	Manila Bay	MMEIRS Map 1:5000 SEDLMM Map 1:2500	2003	PTM III	Polygon	Arcview	This shapefile contains water body of Manila Bay extracted from year 2003 MMEIRS JICA map.	FID			
									SHAPE			
									JICA_CODE	String	15	New Code from DICAMM project
METEOHYDROLOGY	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Meteohydrology											
Meteorological Station	MC_MeteoSta.shp	Meterologigal Station in Metropolitan Manila	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains Meterologigal stations. The location data was provided by PAGASA/CAB/CDS and EFCOS	FID			
									SHAPE			
									No	Number	10	Number of Station
									Name	String	20	Name of Station
									Easting	Number	19	Location in PTM III
									Northing	Number	19	Location in PTM III
									Code	Number	19	PAGASA Code
									Location	String	254	City name that station locates
									Elevation	Number	19	Elevation in meters based on DPWH Datum
									Category	String	254	Category of Station
									Type	String	254	Type of Station
									Obser_Item	String	254	Observation items
									Agency	String	254	Agency in charge
									Date_Estab	Number	19	Established year
									Date_Close	Number	19	Closed year
									Status	String	254	Operation condition in 2004 (Note: "-999" means "no data")
Water Level Station	MC_WLSta.shp	Water Level Station in Metropolitan Manila	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains water level stations. The location data was provided by EFCOS.	FID			
									SHAPE			
									Name	String	254	Name of Station
									Easting	Number	19	Location in PTM III
									Northing	Number	19	Location in PTM III
									LAT	Number	30	Latitudinal location of station
									LONG	Number	30	Longitude location of station
									River	String	254	Observed river
									City	String	254	City name that station locates
									Category	String	254	Category of Station
									Type	String	254	Type of Station
									Obser_Item	String	254	Observation items
									Agency	String	254	Agency in charge
									Date_Estab	Number	19	Established year
									Date_Close	String	254	Closed year
									Status	String	254	Operation condition in 2004
Tide Level Station	MC_TideSta.shp	Tide Level Station in Metropolitan Manila	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains a tide level station. The location data was provided by NAMRIA	FID			
									SHAPE			
									Name	String	254	Name of Station
									Easting	Number	19	Location in PTM III
									Northing	Number	19	Location in PTM III
									LAT	Number	30	Latitudinal location of station
									LONG	Number	30	Longitude location of station
									Location	String	254	Locatin of stations
									Type	String	254	Type of Station
									Obser_Item	String	254	Observation items
									Agency	String	254	Agency in charge
									Date_Estab	String	254	Established year
									Date_Close	String	254	Closed year
									Status	String	254	Operation condition in 2004
Thiessen Polyline	MC_Thiessen.shp	Thiessen Polyline	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains Thiessen Polylines	FID			
									SHAPE			
									ID	String	11	ID for Thiessen Polyline
									Start_NODE	Number	11	
									End_NODE	Number	11	
									Resistance	Number	19	length of each polyline in meter unit
WASTE MANAGEMENT	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\WasteManagement											
Waste Survey Point	WC_SurveyPoint.shp	Waste Survey Point	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains survey point of waste & garvage in the JICA Study.	FID			
									SHAPE			
									JICA_CODE	String	10	DG:Drainage garbage, FG: Floating garbage, PG: Pumping Station
GEOLOGY	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Geology											
Geological Formations	G_Formation1.shp	Geological Formations - Phivolcs	Phivolcs	2000	PTM III	Polygon	Arcview	This shapefile contains geological formations of the Study Area. The original shape file from 2003 MMEIRS Database included all the Metro Manila Area. Original shape file was trimmed in the Study area boundary.	FID			
									SHAPE			
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									FORMATION	String	128	Description
	G_Formation2.shp	Geological Formations - Oyo	Oyo	2003	PTM III	Polygon	Arcview	This shapefile contains geological formations of the Study Area. The original shape file from 2003 MMEIRS Database included all the Metro Manila Area. Original shape file was trimmed in the Study area boundary.	FID			
									SHAPE			
									FORMATION2	String	16	Description
ENVIRONMENT	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Environment											
Water Quality	EC_WaterQuality.shp	Water Quality survey result	JICA Study	2000	PTM III	Point	Arcview	This shapefile contains locations and results of water quality survey in 2004 JICA Study.	FID			
									SHAPE			
									DICA_Code	String	10	JICA Study code in 2004
									Site	String	100	Sampling site
									Temp	Number	19	Temperature (°C) on site
									pH_on_site	Number	19	pH on site analysis
									DO_on_site	Number	19	DO (mg/L) on site analysis
									EC_on_site	Number	19	Electric Conductivity (μS) on site analysis
									BOD_5	Number	19	BOD_5 (mg/L)

Table A.3.2 Detailed List of GIS Data (10/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									COD	Number	19	COD (mg/L)
									Coliform	String	15	Total Coliform (MPN/100mL)
									Phosphate	Number	19	Total Phosphate (mg/L)
									Nitrogen	Number	19	Total Nitrogen (mg/L)
Sediment Quality	EC_SedimentQuality.shp	Sediment Quality survey result	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations and results of sediment survey in 2004 JICA Study.	FID			
									SHAPE			
									DICA_Code	String	10	JICA Study code in 2004
									Site	String	100	Sampling site
									Temp	String	15	Temperature (°C)
									Arsenic	String	15	Arsenic (mg/L)
									Barium	Number	19	Barium (mg/L)
									Cadmium	Number	19	Cadmium (mg/L)
									Chromium	Number	19	Chromium (mg/L)
									Lead	Number	19	Lead (mg/L)
									Mercury	String	15	Total Mercury (mg/L)
									Selenium	String	15	Selenium (mg/L)
									Copper	String	15	Copper (mg/L)
									Nickel	Number	19	Nickel (mg/L)
									Tin	String	15	Tin (mg/L)
									Zinc	Number	19	Zinc (mg/L)
									Fluoride	String	15	Fluoride (mg/L)
									Cyanide	String	15	Cyanide (mg/L)
									Chrom_Hexa	Number	19	Chromium Hexavalent (mg/L)
									Formaldehy	String	15	Formaldehyde (μ/g)
									Organophos	String	15	Organophosphate (mg/L)
									Alkyl_Merc	String	15	Alkyl Mercury (mg/L)
									Hyd_Sulfid	String	15	Hydrogen Sulfide (mg/L)
									Igni_Loss	Number	19	Ignition Loss (%)
Pollution Source	EC_PollutionSource.shp	Pollution source survey result	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains locations and results of pollution source survey in 2004 JICA Study.	FID			
									SHAPE			
									DICA_Code	String	12	JICA Study code in 2004
									Establish	String	49	Name of Establishments
									Address_E	String	58	Address
									Type_Estab	String	100	Type of Establishments
									Type_Indus	String	53	Type of Industry
									City	String	10	City name that establishments exist
									Estero/Crk	String	23	River / Estero
									The following attributes indicate the significant parameter to be surveyed for each establishments. "notable" means items to be surveyed.			
									BOD_5	String	9	BOD5
									pH	String	9	pH
									Susp_Solid	String	9	Suspended Solids
									Sett_Solid	String	9	Settleable Solids
									Oil_Grease	String	9	Oil & Grease
									Dis_Solid	String	9	Dissolved Solids
									Temp	String	9	Temp.
									COD	String	9	COD
									Chrom_Hexa	String	9	Hexavalent Chromium
									Phenols	String	9	Phenols
									Phosphate	String	9	Phosphate
									Chloride	String	9	Chloride
									Chromium	String	9	Chromium
									Nitrate	String	9	Nitrate
									TSS	String	9	TSS
									TotalSolid	String	9	Total Solids
									Sulfates	String	9	Sulfates
									Color	String	9	Color
									T_Coliform	String	9	Total Coliform
									Toxic_Mate	String	9	Toxic Materials
									Alkalinity	String	9	Alkalinity
									Mine_Acid	String	9	Mineral Acid
									VolOrgComp	String	9	Volatile Organic Compounds
									AlkalineWW	String	9	Alkaline Wastewater
									Cyanide	String	9	Cyanide
									Ammonia	String	9	Ammonia
									PCB	String	9	Polychlorinated Biphenyls (PCB)
									Formaldehy	String	9	Formaldehyde
									Ca	String	9	Ca
									Mg	String	9	Mg
SOCIAL CONDITIONS	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\SocialConditions											
Barangay Boundaries	SC_BgyBnd.shp	Barangay Boundaries	MMDA/NSO	2000	PTM III	Polygon	Arcview	This shapefile contains the barangay boundaries of Metro Manila as of 2000. The origin of this shapefile is 2003 MMEIRS Database, and population data is based on the census conducted by the National Statistics Office in 2000. Through the DICA 2004 Study, data of number of informal setteiers were added.	FID			
									Shape			
									Area	Number	19	Area of Barangay
									CityCode	Number	10	City Code by MMEIRS
									Pop2K	Number	15	Barangay population as of year 2000.
									Geocode	String	10	Geocode of Barangay (NSO Standard)
									Name2002	String	50	Name of Barangay as of 2002
									PopDenGros	Number	16	Gross population density in Persons per Ha.
									PopDens	Number	16	
									GeoDistric	String	10	District Classification (for in Manila City, for others GEOCODE = GEODISTRIC)
									DRWWAYS	Number	4	Number of Informal settler along waterway
									DRRDTRKS	Number	4	Number of Informal settler along railway
									PASIGRVR	Number	4	Number of Informal settler along Pasig River
									Hsehold2K	Number	9	Barangay household number as of year 2000.
City/Municipal Boundaries	S_CityBnd.shp	City/Municipal Boundaries	MMDA (MMEIRS)	2000	PTM III	Polygon	Arcview	This shapefile contains the boundaries of all 17 cities and municipalities in Metro Manila in 2000. This shapefile is from 2003 MMEIRS.	FID			
									Shape			
									Municipali	String	128	Name of City or Municipality
									CITYCODE	Number	16	City code assigned by MMEIRS
									Area	Number	18	Area in meter unit
									Pop2k	Number	9	Population in year 2000 from NSO.
									HouseHld2K	Number	9	Households in 2000 (NSO)
									HousePop2k	Number	9	Household population in 2000 (NSO)
									CityDen2k	Number	16	Gross Pop density in 2000

Table A.3.2 Detailed List of GIS Data (11/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									Zone	String	10	
	S_CityBnd2003.shp	City/Municipal Boundaries in 2003	MMEIRS	2003	PTM III	Polygon	Arcview	This shapefile contains the boundaries of all 17 cities and municipalities in Metro Manila in 2003. This shapefile is from 2003 MMEIRS.	FID			
									Shape			
									Municipali	String	254	Name of City or Municipality
									Min_CityCo	Number	4	City code assigned by MMEIRS
EIS01 (Survey for Estero Informal Settlers along selected Esteros)	EIS01_Building.shp	Building along Estero de Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains buildings and these type along estero de Sunog Apog and Tripa de Gallina. Type of building was surveyed in the field through 2004 JICA Study.	FID			
									Shape			
									Type_Build	String	15	Type of building
	EIS01_Building_Clip.shp	Building within Estero de Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains buildings and these type within estero de Sunog Apog and Tripa de Gallina. Type of building was surveyed in the field through 2004 JICA Study.	FID			
									Shape			
									Type_Build	String	15	Type of building
									SecCode	String	10	Section code of estero
Building									AREA	Number	11	Area of buildings in meter units
	EIS01_DenseArea.shp	Densely Buildup Area along Estero de Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains densely buildup area along estero de Sunog Apog and Tripa de Gallina. Household density was set based on the field survey through 2004 JICA Study.	FID			
									Shape			
									DENSITY	Number	19	Household density. (Number of household per sq.m)
	EIS01_DenseArea_Clip.shp	Densely Buildup Area within Estero de Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains densely buildup area and number of households within estero de Sunog Apog and Tripa de Gallina. Household number was calculated using density and area.	FID			
									Shape			
									Density	Number	19	Household density. (Number of household per sq.m)
									Area	Number	19	Densely build-up area in meter units
									HH_Number	Number	10	Number of calculated households
									SecCode	String	10	Section code of estero
	EIS01_Reach00.shp	Area of Water Body of Selected Esteros	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains area of water body of estero de Sunog Apog and Tripa de Gallina.	FID			
									Shape			
									SecCode	String	10	Section code of estero
									Area	Number	11	in meter units
	EIS01_Reach04.shp	Area of 4m outside from Edge of Selected Esteros	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains area of 4m outside from edge of estero de Sunog Apog and Tripa de Gallina.	FID			
									Shape			
									SecCode_RB	String	10	Section code and riverbank indication of estero
									Area	Number	11	in meter units
Reach	EIS01_Reach10.shp	Area of 10m outside from Edge of Selected Esteros	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains area of 10m outside from edge of estero de Sunog Apog and Tripa de Gallina.	FID			
									Shape			
									SecCode_RB	String	10	Section code and riverbank indication of estero
									Area	Number	11	in meter units
	EIS01_Reach20.shp	Area of 20m outside from Edge of Selected Esteros	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains area of 20m outside from edge of estero de Sunog Apog and Tripa de Gallina.	FID			
									Shape			
									SecCode_RB	String	10	Section code and riverbank indication of estero
									Area	Number	11	in meter units
	EIS01_EmbankmentType.shp	Type of Embankment along Selected Esteros	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains type of embankment along estero de Sunog Apog and Tripa de Gallina.	FID			
									Shape			
									TYPE	String	128	Type of embankement
									LENGTH	Number	19	in meter unit
Structure									SecCode_RB	String	10	Section code and riverbank indication of estero
	EIS01_Road.shp	Roads along Selected Esteros	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains roads along estero de Sunog Apog and Tripa de Gallina.	FID			
									Shape			
									SecCode_RB	String	10	Section code and riverbank indication of estero
									Area	Number	11	in meter units
EIS02 (Survey for Estero Informal Settlers along Esteros except two)	EIS02_Building_SSHW.shp	Buildings along South Super Highway and Sen. Gil J. Puyat Avenue	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile includes buildings along South Super Highway and Sen. Gil J. Puyat Avenue	FID			
									Shape			
									Area	Number	19	in meter unit
	EIS02_DenseArea.shp	Densely Buildup Area along Esteros except Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains densely buildup area along esteros except estero de Sunog Apog and Tripa de Gallina Household density was set based on the field survey through 2004 JICA Study.	FID			
									Shape			
									DENSITY	Number	19	Household density. (Number of household per sq.m)
	EIS02_DenseArea_Clip.shp	Densely Buildup Area within Esteros except Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains densely buildup area and number of households within esteros except estero de Sunog Apog and Tripa de Gallina. Household number was calculated using density and area.	FID			
									Shape			
									Density	Number	19	Household density. (Number of household per sq.m)
									Area	Number	19	Densely build-up area in meter units
									HH_Number	Number	10	Number of calculated households
									SecCode	String	10	Section code of estero
	EIS02_EsteroReach.shp	Area of Water Body of Esteros except Sunog Apog and Tripa de Gallina	JICA Study	2004	PTM III	Polygon	Arcview	This shape file contains area of water body of esteros except estero de Sunog Apog and Tripa de Gallina	FID			
									Shape			
									SecCode	String	10	Section code of estero
									Area	Number	11	in meter units

SOCIO-ECONOMIC CONDITION: \DICAMM_Database\GIS_Data\Shape\ExistingConditions\SocioEconomicConditions

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
Land Price	SC_landprice.shp	Land price	LGUs	2004	PTM III	Line	Arcview	This shapefile contains road centerlines with land price in Core Area and surrounding of Metro Manila. Land price data was provided from LGUs, of which appraised year was various in each LGU.	FID			
									SHAPE			
								Appraised year of land price input to this database:	Key86	String	254	Key used to link with MMDA road data
								Manila: 1996, Makati: 1996, Pasay: 2002, Queson: 1994, Kalookan: 1992	NAME	String	254	Name of Road
									OLD_NAME	String	50	Old Name of Road
									Lane	Number	5	Number of Lanes
									Wid_DPWH	Number	19	Road width extracted from DPWH road inventory
									Wid_Calc	Number	19	Calculated road width based on MMDA # of lanes
									Wid_MMEIRS	Number	19	Road width extracted from MMEIRS 2003 drawing
									Type	String	20	Name of Road
									Way	String	10	Represents direction of traffic
									ClassMMDA	String	20	Road classification of MMDA
									Key86_comb	String	16	Key used to link with land price data
									LandPrice	Number	19	Landprice per square meter (Note: "-999" means "no data")
	Landprice	landprice grid map in Raster Format	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains landprice grid based on 'SC_landprice .shp' data in raster format in Study Area and surroungdings.				

Table A.3.2 Detailed List of GIS Data (12/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
	Landprice_n	landprice grid map in Raster Format	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains landprice grid based on 'SC_landprice .shp' data in raster format in the Northern part of Study Area.				
	Landprice_s	landprice grid map in Raster Format	JICA Study	2004	PTM III	Raster	Arcview	This shapefile contains landprice grid based on 'SC_landprice .shp' data in raster format in Southern part of Study Area.				
LANDUSE	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Landuse											
Landuse	LC_Landuse_N.shp	Land Use of Northern Part of Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains landuse in the Northern part of Study Area	FID			
									Shape			
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									LU_CLASS	String	10	Landuse Classification
									Comment	String	254	Description of classification
	LC_Landuse_S.shp	Land Use of Southern Part of Study Area	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains landuse in the Southern part of Study Area	FID			
									Shape			
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									LU_CLASS	String	10	Landuse Classification
									Comment	String	254	Description of classification
	LC_Landuse_Per_SubBasin_N.shp	Land Use per Sub Basin	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains landuse for Sub-Basin in the Northern part of the Study Area	FID			
									Shape			
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									LU_CLASS	String	10	Landuse Classification
									DICA_ID	String	20	Sub-basin ID from DICAMM project
	LC_Landuse_Per_SubBasin_S.shp	Land Use per Sub Basin	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains landuse for Sub-Basin in the Southern part of the Study Area	FID			
									Shape			
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									LU_CLASS	String	10	Landuse Classification
									DICA_ID	String	20	Sub-basin ID from DICAMM project
BUILDING	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Building											
Building	BC_Building_Poly_N.shp	Polygon of Building	MMEIRS	2003	PTM III	Polygon	ArcView	This shapefile contains all the buildings in the Northern part of Study Area.	FID			
									Shape			
									AREA	Number	19	Building area in meter unit (square meter)
									PERIMETER	Number	19	Perimeter of building in meter unit
									ID2	String	10	Building Code to identify each building
	BC_Building_Poly_S.shp	Polygon of Building	MMEIRS	2003	PTM III	Polygon	ArcView	This shapefile contains all the buildings in the Southern part of Study Area.	FID			
									Shape			
									AREA	Number	19	Building area in meter unit (square meter)
									PERIMETER	Number	19	Perimeter of building in meter unit
									ID2	String	10	Building Code to identify each building
	BC_Building_Point_N.shp	Center Point of Building	MMEIRS	2003	PTM III	Point	ArcView	This shapefile contains center points of all the buildings in the Northern part of Study Area.	FID			
									Shape			
									AREA	Number	19	Building area in meter unit (square meter)
									ID2	String	10	Building Code to identify each building
	BC_Building_Point_S.shp	Center Point of Building	MMEIRS	2003	PTM III	Point	ArcView	This shapefile contains center points of all the buildings in the Northern part of Study Area.	FID			
									Shape			
									AREA	Number	19	Building area in meter unit (square meter)
									ID2	String	10	Building Code to identify each building
INFRASTRUCTURE	\DICAMM_Database\GIS_Data\Shape\ExistingConditions\Infrastructure											
Roads	IC_RoadCenter.shp	Road Centerlines	JICA Map 1:5000	2003	PTM III	Line	Arcview	This shapefile contains road centerlines in Core Area and surrounding of Metro Manila. Road attributes such as road name, width and other data are attached to the road centerlines.	FID			
									SHAPE			
									Key86	String	254	Key used to link with MMDA road data
									NAME	String	254	Name of Road
									OLD_NAME	String	50	Old Name of Road
									Lane	Number	5	Number of Lanes
									Wid_DPWH	Number	19	Road width extracted from DPWH road inventory
									Wid_Calc	Number	19	Calculated road width based on MMDA # of lanes
									Wid_MMEIRS	Number	19	Road width extracted from MMEIRS 2003 drawing
									Type	String	20	Name of Road
									Way	String	10	Represents direction of traffic
									ClassMMDA	String	20	Road classification of MMDA
	IC_RoadEdge.shp	Road Edges	JICA Map 1:5000	2003	PTM III	Line	Arcview	This shapefile contains edges of all roads in Core area and surrounding of Metro Manila. The roads are classified into layers:	FID			
									SHAPE			
									LAYER	String	255	Orig AutoCad Layer Name 21010-highway/ 21030-road more than 2 m./ 21040-road under const./21050-road less than 2 m.
Railroads	IC_Railroads.shp	Railway Lines	JICA Map 1:5000	2003	PTM III	Line	Arcview	This shapefile contains railway centerlines in Core Area and surrounding of Metro Manila such as MRT LRT & PNR railways	FID			
									SHAPE			
									LAYER	String	255	

2. Master Plan Planning

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
DRAINAGE SYSTEM	\DICAMM_Database\GIS_Data\Shape\MasterPlanPlanning\DrainageSystem											
Esteros/Creeks	DP_Estero_Section_Plan_N.shp	Estero Sections in the Northern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains estero sections for Master Plan, which are parts of extero diveded into several in the Northern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	Estero section code from DICAMM Study in 2004
									Estero_ID	String	10	DICA code of estero
									EsteroName	String	50	Name of estero
									Length	Number	19	Length of each section in meter unit
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel
									Capa_Origl	Number	4	Estimated original discharge capacity of channel

Table A.3.2 Detailed List of GIS Data (13/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
												1: The capacity is more than Q10
												2: The capacity is Q10 - Q5
												3: The capacity is Q5 - Q3
												4: The capacity is Q3 - Q2
												5: The capacity is less than Q2
												6: Not specified
									Vol_Dredge	Number	19	Dredging volume (m3)
									Dred_Depth	Number	19	Average dredging depth (m)
									Width	String	10	Equivalent width of channel (m)
									Water_Area	String	10	Area of Water body (m2)
									Build_Area	String	10	Total building and dense area within channel (m2)
									PCTBldArea	String	10	Percentage of ("building area"/ "water area") (%)
									Num_Build	String	10	Estimated number of buidlings within channel
									N_Bld_1km	String	10	Estimated number of buidlings within channel per length (km-1)
									Dred_Prior	Number	4	Dredging priority
	DP_Estero_Section_Plan_S.shp	Estero Sections in the Southern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains estero sections for Master Plan, which are parts of extero diveded into several in the Southern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	Estero section code from DICAMM Study in 2004
									Estero_ID	String	10	DICA code of estero
									EsteroName	String	50	Name of estero
									Length	Number	19	Length of each section in meter unit
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel
									Capa_Origl	Number	4	Estimated original discharge capacity of channel
												1: The capacity is more than Q10
												2: The capacity is Q10 - Q5
												3: The capacity is Q5 - Q3
												4: The capacity is Q3 - Q2
												5: The capacity is less than Q2
												6: Not specified
									Vol_Dredge	Number	19	Dredging volume (m3)
									Dred_Depth	Number	19	Average dredging depth (m)
									Width	String	10	Equivalent width of channel (m)
									Water_Area	String	10	Area of Water body (m2)
									Build_Area	String	10	Total building and dense area within channel (m2)
									PCTBldArea	String	10	Percentage of ("building area"/ "water area") (%)
									Num_Build	String	10	Estimated number of buidlings within channel
									N_Bld_1km	String	10	Estimated number of buidlings within channel per length (km-1)
									Dred_Prior	Number	4	Dredging priority
	DP_Estero_Plan_CS_N.shp	Cross Section Point of Esteros in the Northern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains detailed information of cross section surveyed in 2000 SEDLMM and in 2004 DICA study, and Master Plan planning of cross section in the Northern part of Study Area.	FID			
									SHAPE			
									DICA_Code	String	15	New code from DICAMM Study in 2004
									Estero_ID	String	254	DICA code of estero
									Station	String	254	name of station for estero cross section
									Study_Name	String	255	Study name that survey was conducted
									YearSurvey	Number	11	Surveyed year
									Xcoor_Post	Number	19	x-coordination of cross section post
									Ycoor_Post	Number	119	y-coordination of cross section post
									Elev_Post	Number	19	Elevation of Post
									Elev_Lbank	Number	19	Elevation of left bank elevation
									Elev_Rbank	Number	19	Elevation of right bank elevation
									Width	Number	19	Width of extero
									Ex_BedElev	Number	19	Existing river bed elevation
									Pl_BedElev	Number	19	Planned river bed elevation (Note: "-999" means "no data")
	DP_Estero_Plan_CS_S.shp	Cross Section Point of Esteros in the Northern part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains detailed information of cross section surveyed in 2000 SEDLMM and in 2004 DICA study, and Master Plan planning of cross section in the Southern part of Study Area.	FID			
									SHAPE			
									DICA_Code	String	15	New code from DICAMM Study in 2004
									Estero_ID	String	254	DICA code of estero
									Station	String	254	name of station for estero cross section
									YearSurvey	Number	5	Surveyed year
									Study_Name	String	10	Study name that survey was conducted
									Xcoor_Post	Number	19	x-coordination of cross section post
									Ycoor_Post	Number	19	y-coordination of cross section post
									Elev_Post	Number	19	Elevation of Post
									Elev_Lbank	Number	19	Elevation of left bank elevation
									Elev_Rbank	Number	19	Elevation of right bank elevation
									Width	Number	19	Width of extero
									Ex_BedElev	Number	19	Existing river bed elevation
									Pl_BedElev	Number	19	Planned river bed elevation (Note: "-999" means "no data")
Drainage Mains	DP_DM_Section_Plan_N.shp	Drainage Main Sections in the Northern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains drainage main sections for Master Plan, which are parts of DM diveded into several in the Northern part of Study Area. These was used for analysis and planning.	FID			
									SHAPE			
									SecCode	String	10	Estero section code from DICAMM Study in 2004
									DM_ID	String	10	DICA code of drainage main
									DM_Name	String	50	Name of drainage main
									Length	Number	19	Length of each section in meter unit (Note: Length of 1st section is measured from junction of extero center line)
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel
									Capa_Origl	Number	4	Estimated original discharge capacity of channel
												1: The capacity is more than Q10
												2: The capacity is Q10 - Q5
												3: The capacity is Q5 - Q3
												4: The capacity is Q3 - Q2
												5: The capacity is less than Q2
												6: Not specified
									Vol_Dredge	Number	19	Dredging volume (m3)
									Vol_per_1m	Number	19	Dredging volume per unit length (m3/m)
									Dred_Prior	String	10	Dredging priority
	DP_DM_Section_Plan_S.shp	Drainage Main Sections in the Southern part	JICA Study	2004	PTM III	Line	Arcview	This shapefile contains drainage main sections for Master Plan,	FID			

Table A.3.2 Detailed List of GIS Data (14/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
								which are parts of DM diveded into several in the Southern part of Study Area. These was used for analysis and planning.	SHAPE			
									SecCode	String	10	Estero section code from DICAMM Study in 2004
									DM_ID	String	10	DICA code of drainage main
									DM_Name	String	50	Name of drainage main
									Length	Number	19	Length of each section in meter unit (Note: Length of 1st section is measured from junction of extero center line)
									Categoty	String	10	Channel category
									Capa_Exist	Number	4	Existing discharge capacity of channel
									Capa_Origi	Number	4	Estimated original discharge capacity of channel 1: The capacity is more than Q10 2: The capacity is Q10 - Q5 3: The capacity is Q5 - Q3 4: The capacity is Q3 - Q2 5: The capacity is less than Q2 6: Not specified
									Vol_Dredge	Number	19	Dredging volume (m3)
									Vol_per_1m	Number	19	Dredging volume per unit length (m3/m)
									Dred_Prior	String	10	Dredging priority
Drainage Basins	DP_Block_Plan_N.shp	Drainage Block for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage block for Master Plan in the Northern part of the Study Area.	FID			
									SHAPE			
									BLOCK_ID	String	254	ID for drainage block
									Block_Name	String	50	Name of drainage block
									Area	Number	16	in meter unit
									F_RO_Coeff	Number	11	Future runoff coefficient for MP calculation
	DP_Block_Plan_S.shp	Drainage Blockfor Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage block for Master Plan in the Southern part of the Study Area.	FID			
									SHAPE			
									BLOCK_ID	String	254	ID for drainage block
									Block_Name	String	50	Name of drainage block
									Area	Number	16	in meter unit
									F_RO_Coeff	Number	11	Future runoff coefficient for MP calculation
	DP_Basin_Plan_N.shp	Drainage Basins for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage basin for Master Plan in the Northern part of the Study Area..	FID			
									Shape			
									BASIN_ID	String	254	ID for drainage basins
									Area	Number	19	in meter unit
									F_RO_Coeff	Number	11	Future runoff coefficient for MP calculation
	DP_Basin_Plan_S.shp	Drainage Basins for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage basin for Master Plan in the Southern part of the Study Area..	FID			
									Shape			
									BASIN_ID	String	50	ID for drainage basins
									Area	Number	19	in meter unit
									F_RO_Coeff	Number	11	Future runoff coefficient for MP calculation
	DP_Reach_Plan_N.shp	Drainage Reach Basins for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage reach basin for Master Plan in the Northern part of Study Area.	FID			
									SHAPE			
									REACH_ID	String	20	ID for reach basin
									Area	Number	19	in meter unit
									F_RO_Coeff	Number	11	Future runoff coefficient for MP calculation
	DP_Reach_Plan_S.shp	Drainage Reach Basins for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage reach basin for Master Plan in the Southern part of Study Area.	FID			
									SHAPE			
									REACH_ID	String	254	ID for reach basin
									Area	Number	19	in meter unit
									F_RO_Coeff	Number	11	Future runoff coefficient for MP calculation
	DP_SubBasin_Plan_N.shp	Drainage Sub basins for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage sub basin for Master Plan in the Northern part of Study Area.	FID			
									SHAPE			
									SubBasinID	String	10	ID for sub basin
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									WATERWAY	String	16	ID of basin along same estero or drainage main
									BLOCK_ID	String	10	ID of drainage block
									BASIN_ID	String	10	ID of drainage basin
									REACH_ID	String	10	ID of reach basin
	DP_SubBasin_Plan_S.shp	Drainage Sub basins for Master Plan	JICA Study	2004	PTM III	Polygon	Arcview	This shapefile contains drainage sub basin for Master Plan in the Southern part of Study Area.	FID			
									SHAPE			
									SubBasinID	String	10	ID for sub basin
									AREA	Number	19	in meter unit
									PERIMETER	Number	19	in meter unit
									WATERWAY	String	16	ID of basin along same estero or drainage main
									BASIN_ID	String	10	ID of drainage basin
									BLOCK_ID	String	10	ID of drainage block
									REACH_ID	String	10	ID of reach basin
Probable Discharge	DP_ProbableDischarge_N.shp	Probable Peak Discharge of Specific Point	JICA Study	2004	PTM III	Point	Arcview	This shape file contains probable peak discharge of specific point for Master Plan in the Northern part of the Study Area.	FID			
									SHAPE			
									Block_ID	String	10	ID of drainage block
									Basin_ID	String	10	ID of drainage basin
									WaterWayID	String	10	ID of waterway
									Reach_ID	String	10	ID of reach basin
									Drain_Area	Number	19	Drainage area (km2)
									RO_Coeff	Number	19	Runoff coefficient
									Time_Conce	Number	19	Time of Concentration Tc (hour)
									Factor_Red	Number	19	Areal reduction factor
									Q10	Number	19	Q10 (m3/s)
									Q5	Number	19	Q5 (m3/s)
									Q3	Number	19	Q3 (m3/s)
									Q2	Number	19	Q2(m3/s)
									Remarks	String	20	Remarks
	DP_ProbableDischarge_S.shp	Probable Peak Discharge of Specific Point	JICA Study	2004	PTM III	Point	Arcview	This shape file contains probable peak discharge of specific point for Master Plan in the Southern part of the Study Area.	FID			
									SHAPE			
									Block_ID	String	10	ID of drainage block
									Basin_ID	String	10	ID of drainage basin
									WaterWayID	String	10	ID of waterway

Table A.3.2 Detailed List of GIS Data (15/15)

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
									Reach_ID	String	10	ID of reach basin
									Drain_Area	Number	19	Drainage area (km2)
									RO_Coeff	Number	19	Runoff coefficient
									Time_Conce	Number	19	Time of Concentration Tc (hour)
									Factor_Red	Number	19	Areal reduction factor
									Q10	Number	19	Q10 (m3/s)
									Q5	Number	19	Q5 (m3/s)
									Q3	Number	19	Q3 (m3/s)
									Q2	Number	19	Q2(m3/s)
									Remarks	String	20	Remarks

3. Simulation

INUNDATION MAP \DICAMM_Database\GIS_Data\Shape\Simulaiton\Inundation_Depth_Duration

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
Simulated Inundation Map	n_a1_dep.shp	Simulated Inundation Depth Map	JICA Study Simulation Result	2004	PTM III	Polygon	Arcview	This shapefile contains map of inundation depth in the Northern part of the Study Area in Case A1 flood condition. This was based on the calculation result of mathematical model using MOUSE.	FID			
									SHAPE			
									DEPCODE	String	10	Code of inundation depth 0: 0 - 0.05 m 1: 0.05 - 0.20 m 2: 0.20 - 0.50 m 3: 0.50 - 1.00 m 4: > 1.00 m
									Area	Number	19	Inundation area in meter unit
	n_a2_dep.shp ~ s_p2_dep.shp	Simulated Inundation Depth Maps	JICA Study Simulation Result	2004	PTM III	Polygon	Arcview	These shapefiles contain map of inundation depth of various simulated cases. These were based on the calculation results of mathematical model using MOUSE.	*Attributes are the same as the above.*			
	n_a1_dur2.shp	Simulated Inundation Duration Map	JICA Study Simulation Result	2004	PTM III	Polygon		These shapefile contains map of inundation duration in the Northern part of the Study Area in Case A1 flood condition. This was based on the calculation result of mathematical model using MOUSE.	FID			
									SHAPE			
									DEPCODE	String	254	Code of inundation duration 1: 0 - 3 hrs 2: 3 - 12 hrs 3: 12 - 24hrs 4: > 24 hrs
									Area	Number	19	Inundation area in meter unit
	n_a2_dur2.shp ~ s_p2_dur2.shp	Simulated Inundation Duration Maps	JICA Study Simulation Result	2004	PTM III	Polygon	Arcview	These shapefiles contain map of inundation duration of various simulated cases. These were based on the calculation results of mathematical model using MOUSE.	*Attributes are the same as the above.*			

INPUT DATA \DICAMM_Database\GIS_Data\Shape\Simulaiton\Input_Data

Category	File Name	Description	Sources	Year	Coordinate	Data Type	Format	Abstract	Attribute Name	Type	Width	Definition
Simulated Inundation Points	res_n_a1.shp	Point Data of Simulated Inundation Result	JICA Study Simulation Result	2004	PTM III	Point	Arcview	This shapefile contains point data of inundation calculation result of mathematical model using MOUSE, which was simulated in Case A1 flood condition in the Northern part of the Study Area.	FID			
									SHAPE			
									Node_ID	String	14	Code for simulated point
									X_ordinate	Number	9	X-coordination of the point in PTM III
									Y_ordinate	Number	9	Y-coordination of the point in PTM III
									JR	String	9	Characteristic of the location of the point J: at the drainage junction, R: on the Road
									Depth	Number	9	Maximum inundation depth (m)
									Duration	Number	9	Inndation duration (hrs)
	res_n_a2.shp ~ res_s_p2.shp	Point Data of Simulated Inundation Results	JICA Study Simulation Result	2004	PTM III	Point	Arcview	These shapefiles contain point data of inundation calculation results of mathematical model using MOUSE, which were simulated in various conditions/cases.	*Attributes are the same as the above.*			
Elevation of Simulated Points	Flood_Input_Ele_N.shp	Elevation of Points used to Inundation Calculation in the Northern Part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains elecvation of points used to inundation calculation in the Northern part of the Study Area.	FID			
									SHAPE			
									Node_ID	String	14	Code for simulated point
									X_ordinate	Number	9	X-coordination of the point in PTM III
									Y_ordinate	Number	9	Y-coordination of the point in PTM III
									JR	String	9	Characteristic of the location of the point J: at the drainage junction, R: on the Road
									Elevation	Number	19	Elevation in DPWH Datum (m)
	Flood_Input_Ele_S.shp	Elevation of Points used to Inundation Calculation in the Southern Part	JICA Study	2004	PTM III	Point	Arcview	This shapefile contains elecvation of points used to inundation calculation in the Southern part of the Study Area.	FID			
									SHAPE			
									Node_ID	String	14	Code for simulated point
									X_ordinate	Number	9	X-coordination of the point in PTM III
									Y_ordinate	Number	9	Y-coordination of the point in PTM III
									JR	String	9	Characteristic of the location of the point J: at the drainage junction, R: on the Road
									Elevation	Number	19	Elevation in DPWH Datum (m)

ANNEX A.1

DATA ARRANGEMENT FOR GIS

ANNEX-A.1 DATA ARRANGEMENT FOR GIS

In developing the database, some GIS data needed the especial arrangement of the original data. The details are described below.

1) Topography

Topography for this Study was made in combination with MMEIRS contour and manhole top elevation of SEDLMM.

The process is as follows:

1) To convert the value of manhole top elevation to elevation on the basis of mean sea level, because the value of manhole top elevation of SEDLMM was measured using DPWH Datum.

2) To modify or omit some manhole data with strange elevation or with strange coordinate.

3) To rearrange contours of the Study Area in combination with MMEIRS contour and revised manhole top elevation of SEDLMM.

2) Inundation Data in 1999 Flood

Based on the survey result of 1999 flood in SEDLMM, inundation data in 1999 flood was input and analyzed with the aim of grasping the existing flood conditions.

The survey result of SEDLMM consists of the following data:

- Drawing by CAD, which includes exact coordinate and ID number of survey points
- Detailed survey data by Microsoft Access, which include survey points location defined by street name, inundation depth, inundation duration, cause of inundation and ID number.

The above data are linked by ID number.

The process of inputting is shown below.

- Inundation points

1) To check the location and ID number of survey points, comparing the drawing to the detailed survey data, because some points had the same ID number and some points had no ID number in the drawing.

2) To select available points for analysis from all the inundation survey points data.

- Inundation depth and duration maps in 1999 flood

1) To omit some local inundation points with high inundation depth or with long inundation duration from selected points.

2) To create inundation depth and duration maps using the value of inundation depth or duration of the selected points after omitting.

ANNEX A.2

MANUAL FOR ARCEXPLORER

Annex-A.2 Manual for ArcExplorer

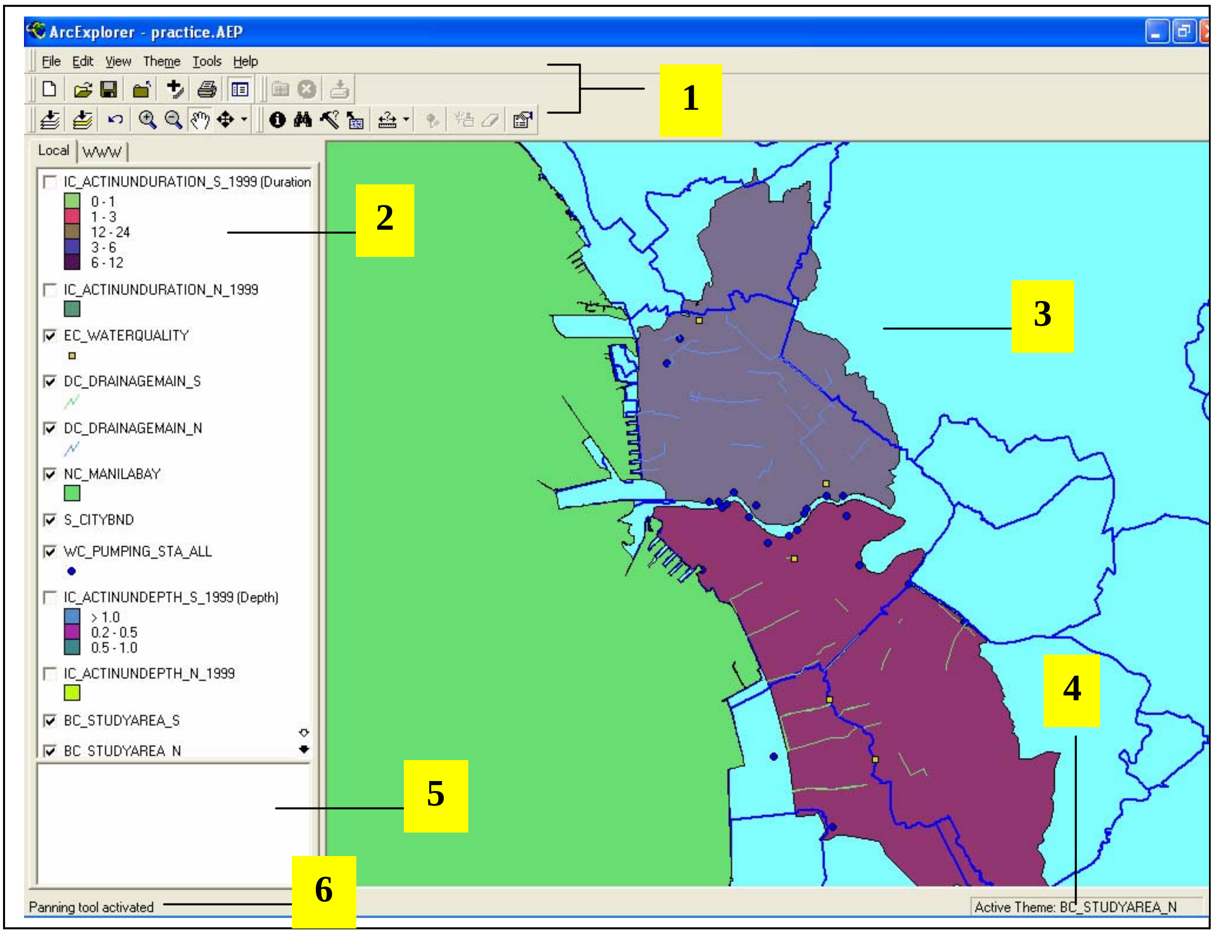
ArcExplorer is a lightweight GIS data viewer developed by ESRI. This freely available software offers an easy way to perform a variety of basic GIS functions, including display, query, and data retrieval applications. It can be used on its own with local data sets or as a client to Internet data and map servers.

What you can do with ArcExplorer

- View and query shapefiles, CAD drawings, etc.
- Display a wide variety of image formats
- Address match (locate street addresses or intersections on a map)
- Measure distances on your map
- Find features
- Identify and query geographic and attribute data
- Display data using classifications, symbols, and labeling
- Pan and zoom through multiple map layers
- View and download data published on Web sites which use ESRI IMS technology.

ArcExplorer also features legends, overview maps, saving and retrieving projects, and map printing.

ArcExplorer Environment



1- **Menu Bar and Toolbars-** to access all the functions of ArcExplorer

2- **Legend-** Displays all the layers of the data as themes, the legends has two tabs: Local for managing locally stored data and WWW for managing data on Web sites

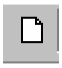
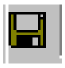
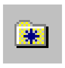
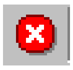
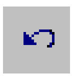
3- **Map View-** Displays the data

4- **Scale Bar-** Displays the scale of the current map view

5- **Overview Map-** Displays and overview map showing the full extent or half the extent of your data, with a red box outlining the area displayed in the map view.

6- **Status Bar-** Shows the help messages on the left and lists the current active theme on the right.

The Toolbars

	**New ArcExplorer**	Starts a new session of ArcExplorer
	**Open project**	Opens an ArcExplorer project (file with an .aep extension) (Local mode only)
	**Save Project**	Saves an ArcExplorer
	**Close Project**	Removes all themes and returns an empty view. Closes the Web map site in WWW.
	**Add Theme(s)**	Adds one or more theme(s) to view. Adds a Web map site in WWW mode
	**Print**	Prints the map view and legend to a preformatted map Layout. (Local mode only)
	**Toggle ArcExplorer**	Toggles the legend on and off
	**AEWeb Favorites**	Opens the AEWeb favorites dialog
	**Cancel WWW**	Request cancels a request map server for a download of WWW data.
	**Retrieve Data from WWW**	Downloads data displayed in the map view from WWW
	**Zoom to full extent**	Zooms to the extent
	**Zoom to Active theme**	Zooms to the extent of active theme (Local mode only)
	**Zoom to previous extent**	Zooms to the last previous extent
	**Zoom in**	Zooms in the position you click or the box you drag on the map

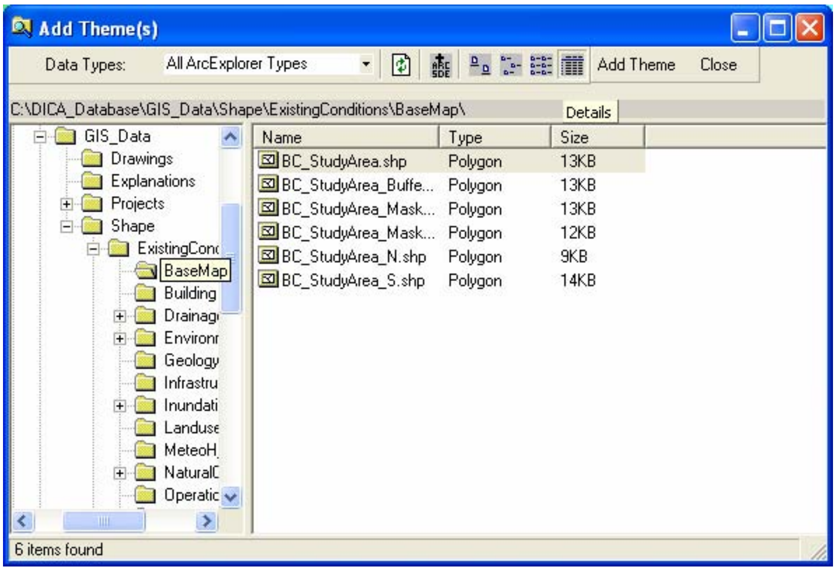
Zoom Out	Zooms out form the position you click or the box you drag on the map view
Pan	Pans the map as you drag the mouse across the map View
Pan Direction	Choose panning direction It has four buttons: North, South, East, and West
Identify	Lists attributes of features you identify by clicking them in the map view
Find	Finds a map feature(s) based on text string you type in.
Query Builder	Queries the active theme based on a query expression you construct.
Map Tips	Displays attribute information for features in the map
Measure	Measures distances on the map view. You must first choose measurement units from the detachable menu.
Address Match	Locates a street address or intersection on the map view.
Clear Thematic Classification	Removes thematic classification from the active Theme
Clear Selection	Clears the selected/highlighted features from the map view.
Theme Properties	Sets the display characteristics of the active theme

Adding Data in ArcExplorer

ArcExplorer has two modes for loading and viewing data: *Local* and *WWW* that can be switch by clicking tabs at the top of the ArcExplorer Legend. In Local mode, we can access data stored in computer or other computers connected to your computer via a network or an ESRI SDE server.

ADDING LOCALLY STORED DATA

1. Click the *Add Theme Button*  to open the Add Themes dialog.



2. For data types, choose the type of data you want to load, or choose *All Other Formats* to see all files stored in the directory.
3. Click on each directory to navigate to the directory where your data are stored.
4. Click the file you wish to add.
5. Click *Add Theme.*
6. Navigate to another directory to add additional themes, or click *Close* to close the Add Themes dialog. The themes you chose appear in the legend.

<u>Shortcuts for adding data to ArcExplorer:</u>

From the Add Themes dialog, you can

- Double-click a file to add it as a theme or
- Drag and drop a file directly into the map view.

This drag and drop functionality also works by dragging a file from your Windows Explorer into a map view.

ADDING DATA FROM THE WEB

1. Click the WWW tab in the legend.
2. Click *Add Theme* Button.

3. Type the URL of a Web site you wish to view data from.
4. Click the Add URL button.
5. If you have entered a URL other than ESRI ArcExplorer Web site, ArcExplorer prompts you to save the URL as one of your AEWeb Favorites. You can choose to save the URL and then enter a name for this new AEWeb Favorite, or choose no to open the URL without saving it as an AEWeb Favorite.
6. The name of the data server appears under AEWeb. Navigate through the directory of available data and click the data you want to add to the map view. A legend listing all the Web-based themes appears below the directory. Use the black and gray arrows to scroll through the list if it extends beyond the legend part.
7. To close a web site

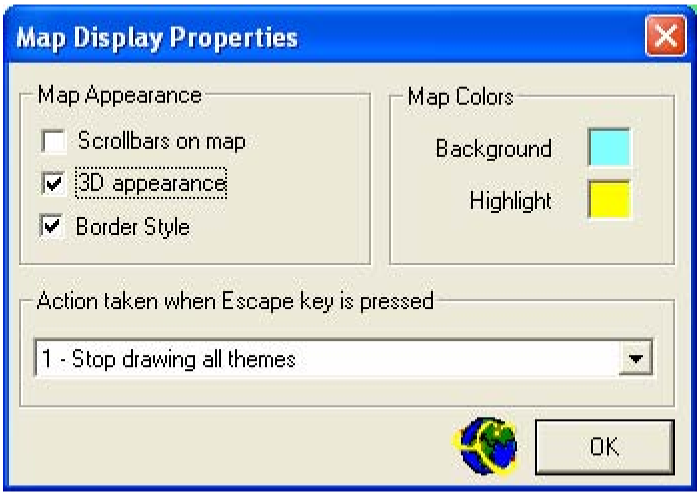
   Select the site in the AEWeb tree view. Click the close WWW Map site button.

Customizing the Map

SETTING MAP DISPLAY PROPERTIES

Control the background color, map outline, scroll bars and other characteristics in map view.

1. Choose *Map Display Properties* from the *View* menu

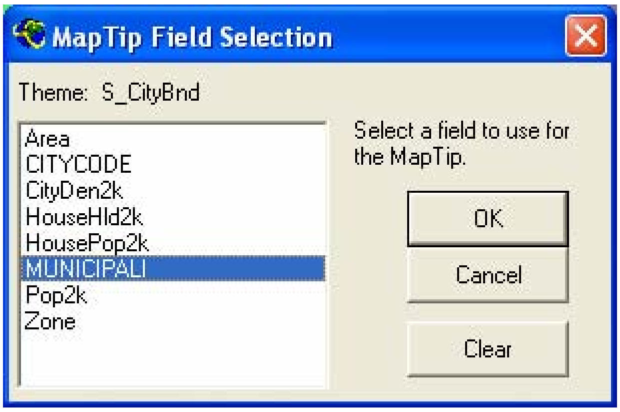


2. Check the Scrollbars on map box if you want the map to include scroll bars at the edge of the map for panning.
3. Check the 3d Appearance box if you want the map view to have a slightly raised effect.
4. Check the border style box if you want to enhance the border of around the map view.
5. Set the background color for the map view by clicking on the Background box and clicking the desired color.
6. Changed the color for highlight by clicking the Highlight box and choosing a desired color. Features found in query are highlighted with this color.
7. Set the escape key to cancel an action. You can set it to stop drawing the all the layers, to stop drawing the current layer, or to do nothing.

CREATING MAP TIPS

Map tips are small pop-ups that display data for field you specify. Map tips work on the active theme as you move the cursor over the features on the map view. (Map tips only work in Local Mode).

1. Make the theme you want to display MapTips for active.
2. Click the *MapTips* tool  to display the MapTips dialog.
3. Choose the field to be displayed in the MapTips and then click ok.



To use the MapTips for a theme:

Move your mouse over features on the map view to display the MapTips. To disable MapTips, click the clear button on the MapTip Field Selection dialog.

ADDING A SCALE BAR TO THE MAP VIEW

1. Choose Display Scale Bar on the view menu to add a scale bar.
2. Right-click the scale bar and set the map, scale and screen units.

Map units are the units in which geographic data are stored.

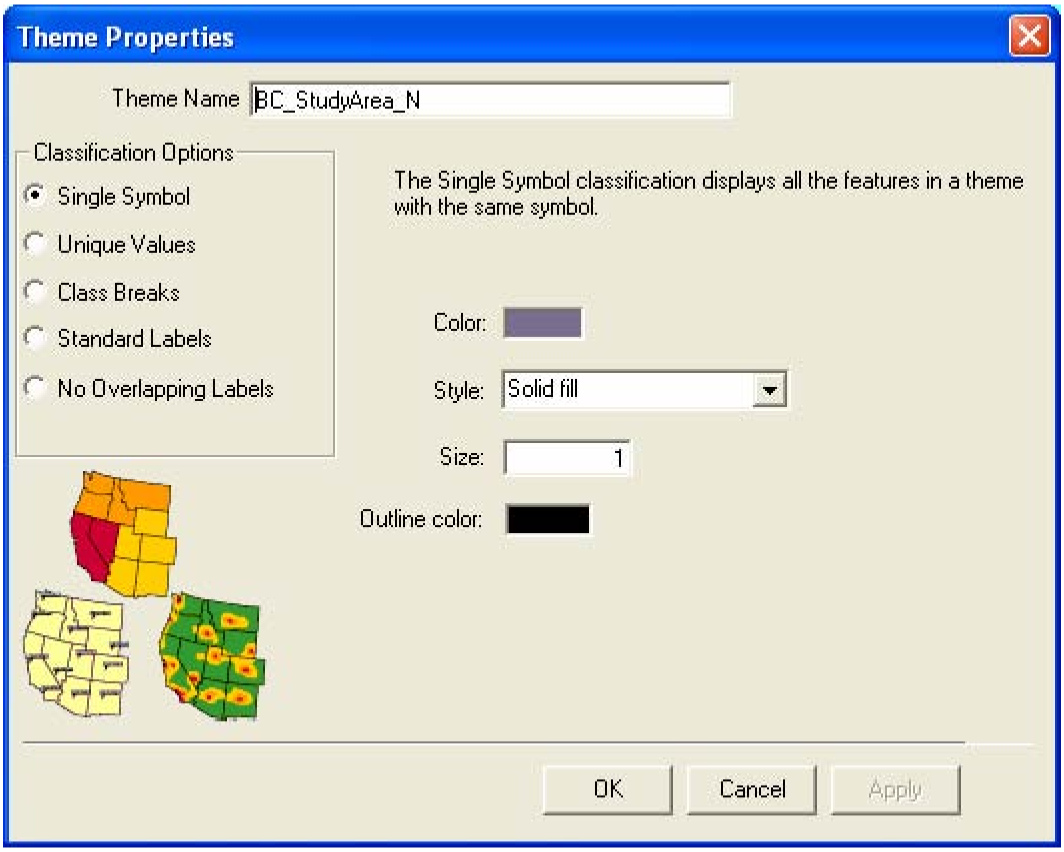
Scale units set as miles, feet, meters or kilometers.

Screen units correspond to the actual display in your computer, set as either inches or centimeters

Symbolizing Data

THEME PROPERTIES DIALOG

This property is used to control how each theme is drawn in the map view: to classify theme's features, method of classification, color scheme for classification, display all the features with same symbol, or label a theme.



<u>Creating Single Symbol Map</u>

Displays the entire feature in the theme with the same color and style.

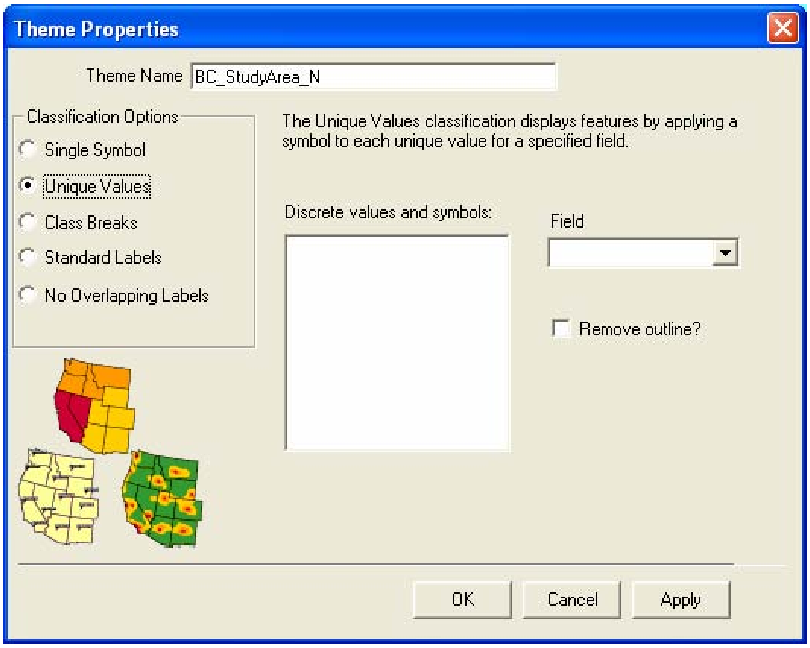
1. Open the Theme Properties dialog
2. Click the color box to change the color or to create a custom color.
3. Click the style box to change the symbol's style.
4. Enter a size value for line width, outline width, or marker size depending on, whether your themes feature type is line area, or point.
5. Click *Apply* to commit your changes and close the Theme Properties dialog at the same time.

Labeling a theme classified as Single Symbol

Open the Theme Properties dialog and first choose the Single Symbol classification. Then choose either Standards Labels or No Overlapping Labels and set the labels for the theme.

Unique Values Map

Displays features by applying a different color to each unique value for specified field.



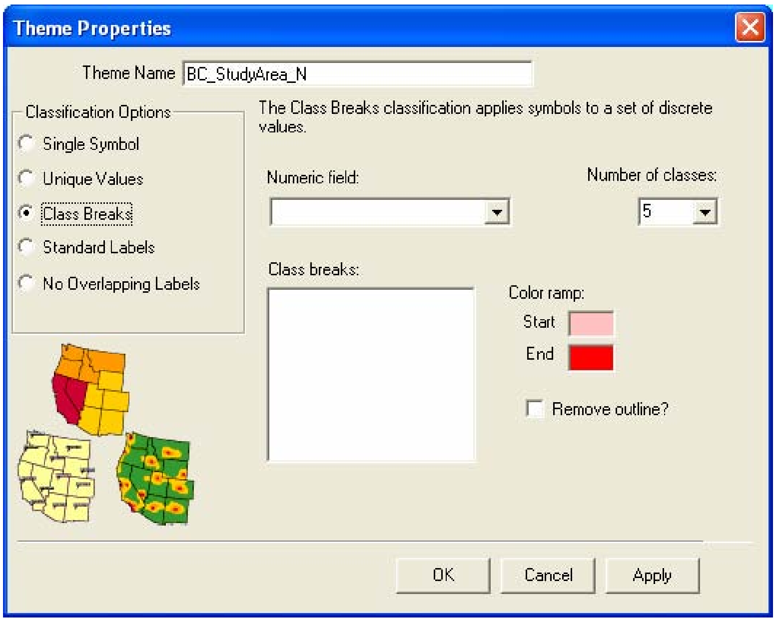
1. Open the Theme Properties dialog
2. Choose Unique Values from the Classification Options.
3. Choose a field.
4. ArcExplorer automatically assigns random colors to each unique classification. Click a color box to change value's color.
5. Check the Remove Outline box if you want polygons drawn with no outline.
6. Click Apply to commit your changes and close the Theme Properties dialog at the same time.

Labeling a theme classified as unique values:

1. Add the theme to your legend twice.
2. Set the second theme as a Label map. Uncheck the draw Features box. Click Ok. Be sure that labeled theme is listed on top of the other theme in the legend so you can see the labels on the top of the map features.

Class Break Maps

Uses quantile classification to create graduated color maps.



1. Open the Theme Properties dialog.
2. Choose Class Breaks from the Classification Options.
3. Pick a Numeric field. This field contains the values that will be mapped. For the numeric field, ArcExplorer is limited for finding the first 2,000 unique values in the data sheet.
4. Choose the number of class you want in your classification.
    a. Click the start and End color boxes to change the starting and ending colors for your color ramp.
    b. Check the Remove Outline Box if you want polygons drawn with no outline.
5. Click Apply to commit your changes or OK to commit the changes and close the Theme Properties dialog at the same time.

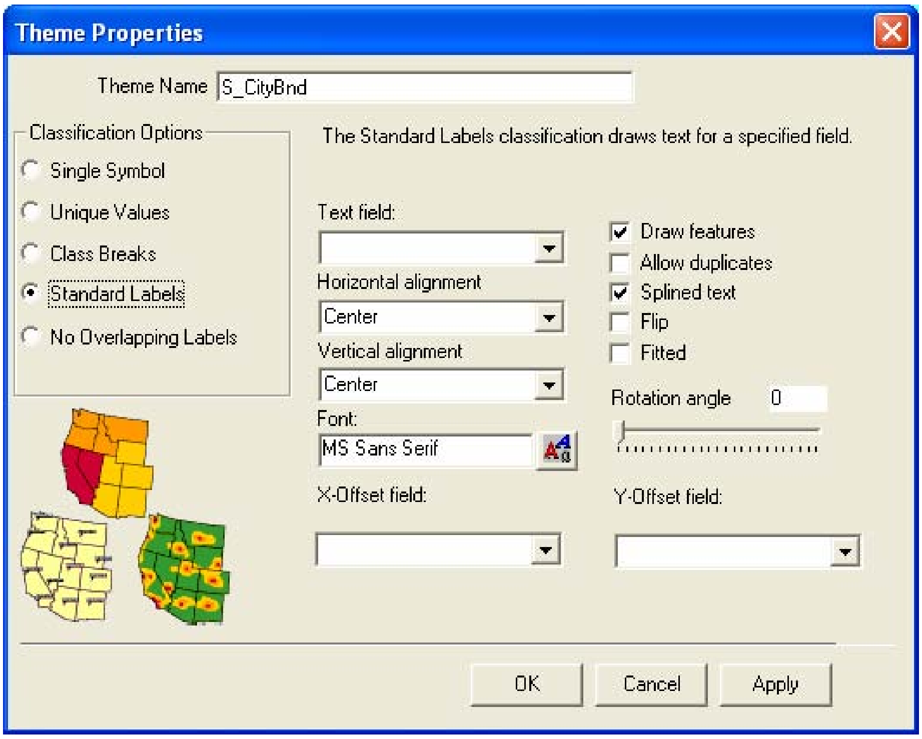
Labeling a theme classified as Class Breaks

1. Add the theme to your legend twice.
2. Set the second theme as a Label map. Uncheck the draw Features box. Click Ok. Be sure that labeled theme is listed on top of the other theme in the legend so you can see the labels on the top of the map features.

LABEL MAPS

Standard Label Maps- labels are placed according to the preferences you choose on the Theme Properties dialog. It provides placement options: splined, fitted, flipped, and rotated.

1. Open the Theme Properties dialog.
2. Click Standard Labels.



3. Choose the Text field.

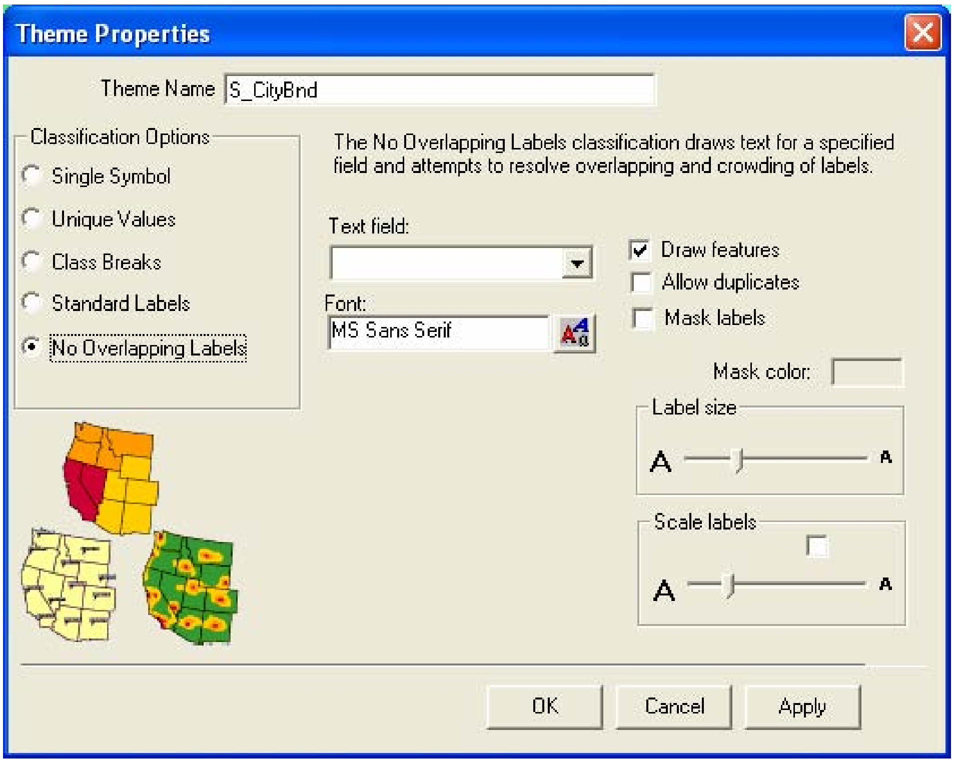
   Options:

   a. Use the vertical and horizontal alignment options to control the label position relative to the center of the feature being labeled.
   b. Click the Font button to change the font, style, size, or color.
   c. For displaying annotation in ARC/INFO coverages or SDE layers, choose an X-Offset and Y-Offset field.
   d. Uncheck draw features to see only the labels and not the features. This is useful when labeling over an identical theme with a thematic classification.
   e. Uncheck the Allow Duplicates box to label features with the same name only once. The advantages of not allowing of duplicates are most obvious for data such as street networks, where each segment of a street has a name field.
      - Check Splined text for labels that follow the shape of its feature.
      - Check Flip to change the orientation of a label.
      - Check Fitted to spread a label across a feature.
      - Choose a value from 0 to 359 if you wish to rotate the labels.

4. Click Apply to commit your changes or click OK to close the Theme Properties dialog at the same.

No Overlapping Map- assesses the features being labeled and attempts to resolve cases where labels are crowded or overlapping.

1. Open the Theme properties dialog

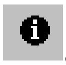


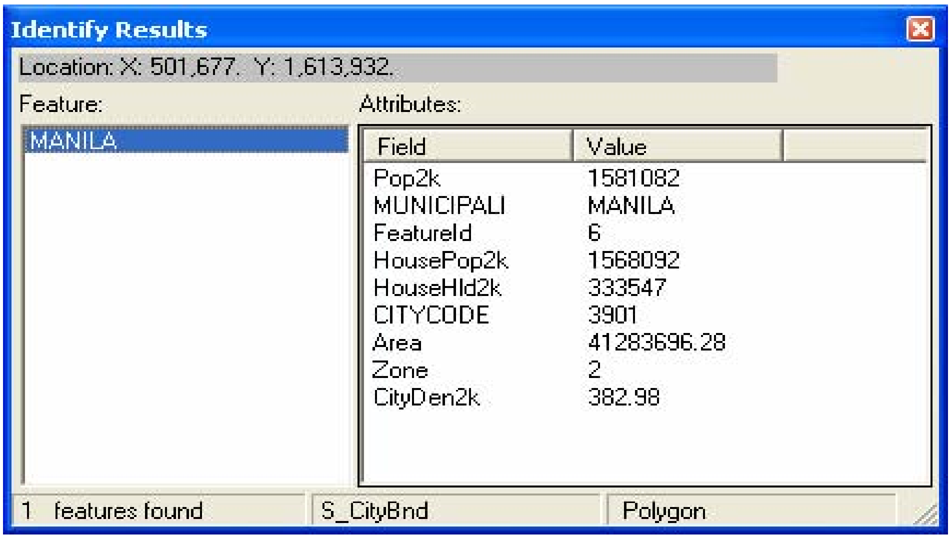
2. Click No Overlapping Labels.
3. Choose a Text field.
    a. Click the font button to change the font, style, size, or color.
    b. Choose a label placement option.
    c. Uncheck draw features to see only the labels and not the features. This is useful when labeling over identical theme with a thematic classification.
    d. Uncheck Allow Duplicate box to label features with the same name only once. The advantages of not allowing duplicates are most obvious for data such as street networks, where each segment of a field has a name field.
    e. Check Mask Labels and you can choose a mask color to be displayed under the label.
    f. Choose the Label Size or check Scale labels and choose scaling factor.
4. Click Apply to commit your changes or click OK to close the Theme Properties dialog at the same.

Getting and using the Attributes of Features

IDENTFYING FEATURES WITH A MOUSE

Use to get information about one of the features in the map.

1. In the legend click the name of the theme you wish to identify to make it active.
2. Click the Identify tool .
3. Click the feature you wish to identify. The feature you click flashes in the map view, and its attributes appear in the Identify Results dialog.



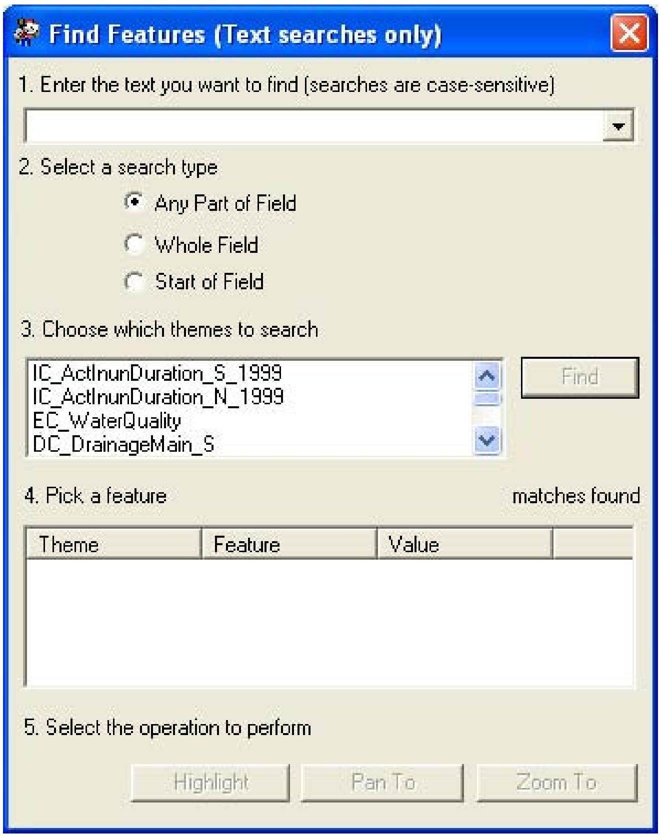
In the Identify Results, panel, indicates the number of features found, and if one or more features are found you can see all the features that were found by using the drop-down functionality on the Features list.

FINDING FEATURES BY NAME

Use to locate particular features from the themes in the map view.

1. Click the find tool

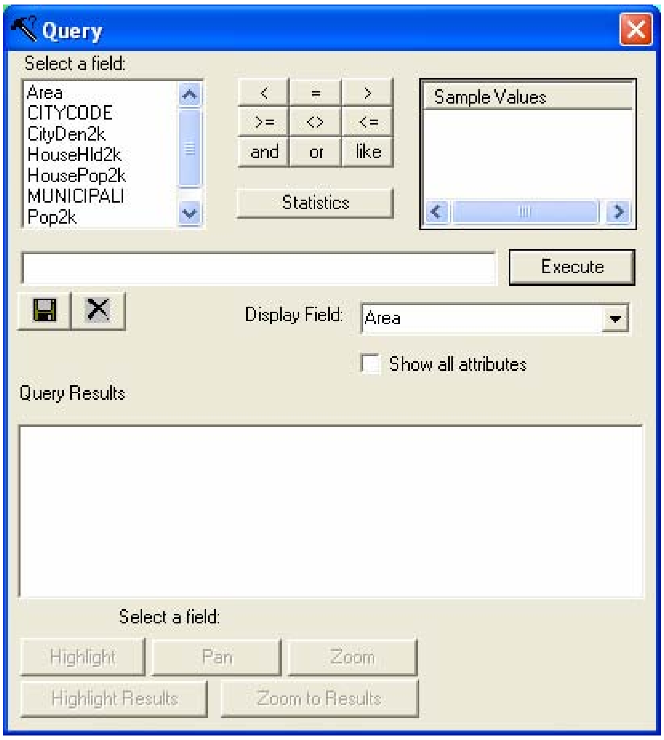
   In the find features dialog,



2. Enter the name of what you want to find. You don't nee to enclose the text you specify in quotes. Find is case sensitive. Wild cards are not supported.
3. Choose a search type. Choose "Any Part of the Field" if you want to enter only part of the search text.
4. Choose which theme or themes to search.
5. Click *find*. ArcExplorer searches the features in the chosen themes to find features that meet the search criteria. ArcExplorer is limited to finding the first 500 features that meet the search criteria.

FINDING FEATURES BY BUILDING A QUERY EXPRESSION

A Query expression is a precise definition of what you want to select. Building a query expression is powerful way to select features because an expression can include multiple attributes, operators, and calculations.

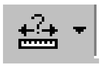


1. Click the name of the theme you wish to query.
2. Click the Query tool.
3. From the list of the fields, click CAPITAL to enter it into the expression.
4. Click the Equal button to enter the = operator into the expression.
5. Click N from the Sample Values list.
   (Example for creating query for POPULATION.)
6. Click the And button to indicate that both parts of the expression must be true.
7. From the list of the fields, click POPULATION
8. Click the *Greater Than* button.
9. Type 1000000 into the expression
10. Click the Execute button. Feature that meet the query definition appear in the Query Results panel. The Query builder is limited to finding only the first 2,000 records that meet the search criteria.

Note: In working with Query we can make different ways to create query builders and results that meets the various analysis using ArcExplorer for example generating summary statistics using the same tool and selecting fields.

USING THE MEASURE TOOL

Use to measure distances in the map.

1. Click the Measure tool  and choose a measurement unit from the detachable menu.
2. On the map view, click and drag to draw a line representing the distance you wish to measure.
   The segment and total length you measured is displayed in the status panel at the top left of the map view.

   To stop measuring and clear the measurements, double-click in the map view. After you double-click, the total length appears in the lower left corner on the status bar.

ADDRESS MATCHING

Address matching involves interpolation; it is not an exact science. Address matching is the process of calculating geographic positions from addresses by interpolating from the address of a street segment, taking into account even and odd address numbering.

Samples of Address Matching:

Before beginning Address Matching, we need to set first the properties for the street file you wish to address match against. (Prepare a theme that meets the requirements for a street file.)

1. Make the street theme you wish to address match against active.
2. From the Theme menu, choose Address Matcher Properties.
3. In the Address Matcher Properties dialog, you must specify the required input fields.
4. Click the Ok to make the theme matchable.

<u>Locating a street address or intersection</u>

What you need:

A street theme that meets the requirements for a street file.

A street theme that has been prepared for address matching through the Address Matcher Properties dialog.

1. Make the street theme that you are address matching against active.

2. Click the Address Matcher button.
3. On the Address Matching dialog, choose whether you will enter an address or an intersection.
4. Type an address or intersection and cross street, city, state, and ZIP Code for the location you want to address match. Enter as much information as you have available to ensure the most accurate address match.
5. Click the Match button. ArcExplorer geocodes the address and, if it can find it, locates it in your map with a point. The map view pans and zooms to the location of the matched address.

Printing and Saving

PRINTING A MAP

1. Click the Print tool
2. Enter a title for your map.
3. Your map will print to your default printer. You can choose Print Setup properties to change printers or to access other printer options.
4. Click Print
   If the legend for your map is too long, it prints onto a second page. ArcExplorer has two-page limit for the legend. If your legend exceeds two pages, you may want to reconsider the symbolization of your map.

SAVING YOUR WORK

<u>Saving Project File</u>

1. Choose the Save Project or Save As from the File Menu, or click the Save tool.
2. If necessary, name your ArcExplorer project.
3. Click OK.

B. METEOROLOGY AND HYDROLOGY

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B.1 GENERAL

In this chapter, meteorological and hydrological conditions in the study area are described. Firstly, inventory of monitoring network and general conditions on the meteo-hydrology are shown. Secondary, results of analysis on meteo-hydrology such as statistics of rainfall intensity are explained.

B.2 MONITORING NETWORK ON METEO-HYDROLOGY

B.2.1 METEOROLOGICAL STATIONS AND DATA

There are four rainfall stations in and around the study area: Port Area, Science Garden, NAIA and Napindan. An inventory on the meteorological stations is presented in *Table B.2.1*. Location map of the meteorological stations is shown in *Figure B.2.1*. Among the four rainfall stations, three stations, i.e. Port Area, Science Garden and NAIA, are climatic stations operated by PAGASA. Port Area station has the longest series of historical rainfall data. Next to Port Area, Science Garden has long historical rainfall data. Unfortunately, the station at NAIA has become irregular since 1993. Measurement method of rainfall at Port Area and NAIA is of automatic type. Measurement method of rainfall at Science Garden was of automatic type up to 2001 but from 2002 it has become telemetric type since EFCOS is using telemetric rainfall data of Science Garden. The rainfall station at Napindan is operated by EFCOS and had been recently installed in 2002.

Available historical time series rainfall data at all the above-mentioned four stations have been collected during the Study. PAGASA central office keeps a record of rainfall data measured by cylinder at 6-hour interval. This data is available in digital form for period 1987-2000 at Port Area and for period 1986-2001 at Science Garden station. Flood Forecasting and Warning Center of PAGASA keeps a record of short duration (chart) rainfall data at Port Area (1949 – 2000), Science Garden (1965 – 1990) and NAIA (1949 – 1991) stations, which is available in digital format. EFCOS keeps a record of hourly rainfall data which is available in digital format for period 2002-2003 at Napindan station. All the digital data have been collected from PAGASA and EFCOS. Also, available tabular rainfall data of 6 hours interval for Port Area (period 1982-1985, 2002-2003), Science Garden (period 1961-1986, 2002-2003) and NAIA (1961-1992) stations have been manually extracted from PAGASA and have been digitized during the Study.

As for general climate data, historical monthly rainfall, temperature and relative humidity data at Port Area, Science Garden and NAIA stations for period 1961-2003 and monthly evaporation at Science Garden for period 1971-2003 have been collected in digital format from PAGASA.

Thiessen polylines for calculating basin mean parameters are shown in *Figure B.2.1*. It is found that Port Area has the most (56%) influence over the Study area, NAIA and Napindan stations have almost same influence (17%) and the rest (10%) is influenced by Science Garden.

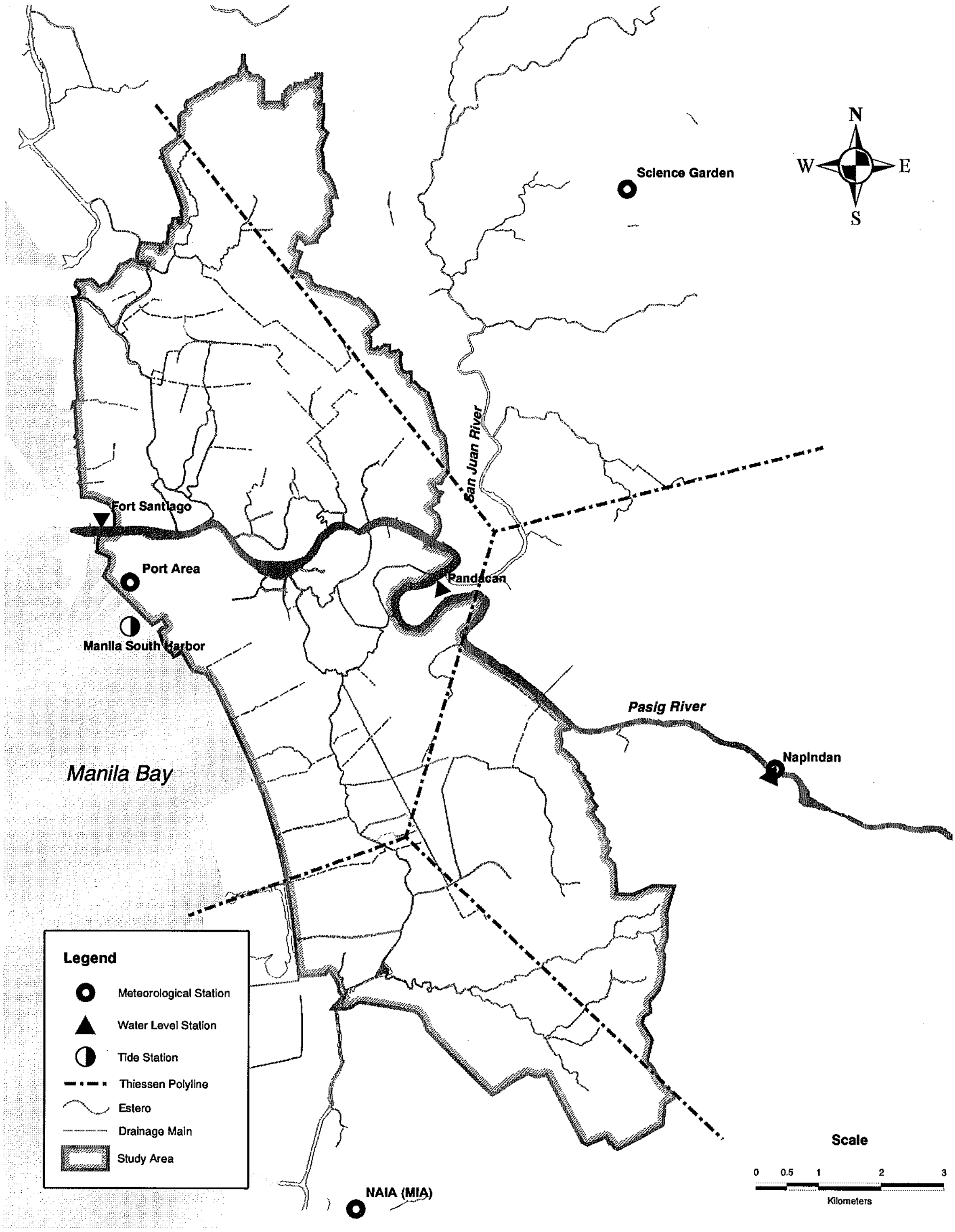


Figure B.2.1 Monitoring Network on Meteo-Hydrology

B.2.2 HYDROLOGICAL STATIONS AND DATA

An inventory on hydrological stations is presented in *Table B.2.2*. There is one primary tide station located at Manila South Harbor, which is operated by NAMRIA. Location map of tide station is shown in *Figure B.2.1*. Daily predicted high and low tide levels (based on MLLW datum) are found in "Tide and Current Tables", which is published by NAMRIA each year. Tide tables for the last five years (1999-2003) have been collected and digitized.

There are three water level stations located along the Pasig River within the reach of the study area, namely Fort Santiago, Pandacan and Napindan. Location map of the water level stations is shown in *Figure B.2.1*. All the stations are operated by EFCOS and are of telemetric type. Fort Santiago and Pandacan stations have been operating since 1993 whereas Napindan station has been installed recently (2002). Digitized hourly water level data (based on DPWH datum) for the full available period (1993-2003 for Fort Santiago and Pandacan and 2002-2003 for Napindan) have been collected from EFCOS.

Table B.2.1 Inventory on Meteorological Stations

No.	Name	Code	Location	Coordinates		Elevation	Category	Type	Observation	Agency	Date of		Status
				Latitude	Longitude	(EL. m)			Items	in Charge	Establishment	Closing	
1	Port Area	425	Manila	14°35' N	120°59' E	16	Synoptic	Automatic	Rainfall, Temperature, Relative Humidity	PAGASA	1951 (present location)		Operational
2	Science Garden	430	Quezon City	14°39' N	121°03' E	43	Synoptic	Automatic upto 2001, Telemetric from 2002	Rainfall, Temperature, Relative Humidity, Pan Evaporation	PAGASA	1951		Operational
3	NAIA (MIA)	429	Pasay City	14°31' N	121°01' E	21	Synoptic	Automatic	Rainfall, Temperature, Relative Humidity, Pan Evaporation	PAGASA	1961		Irregular
4	Napindan		Pasig City	14°33'22" N	121°04'01" E		Rainfall	Telemetric	Rainfall	EFCOS	2002		Operational

Source: PAGASA/CAB/CDS and EFCOS

Table B.2.2 Inventory on Hydrological Stations

No.	Name	River / Bay		Coordinates		"0" Gauge	Category	Type	Observation	Agency	Date of		Status
		River	City	Latitude	Longitude	(EL. m)			Items	in Charge	Establishment	Closing	
1	Fort Santiago	Pasig	Pasig City	14°35'46" N	121°58'07" E		Hydrologic	Telemetric	Water level	EFCOS	1993		Operational
2	Pandacan	Pasig	Manila	14°35'28" N	121°00'40" E		Hydrologic	Telemetric	Water level	EFCOS	1993		Operational
3	Napindan	Pasig	Manila	14°33'22" N	121°04'01" E		Hydrologic	Telemetric	Water level	EFCOS	2002		Operational
4	Manila South Harbor	Manila Bay		14°35' N	120°58' E		Tidal Staion		Predicted Tide level	NAMRIA			Operational

Source: EFCOS and NAMRIA

B.2.3 GENERAL METEO-HYDROLOGICAL CONDITION

(1) Annual Rainfall

Historical variation in annual total rainfall at Port Area, Science Garden and NAIA stations for the period 1961-2003 and at Napindan station for 2002-2003 is shown in *Figure B.2.2.* The figure also shows historical annual total rainfall over the study area as calculated using Thiessen Polygons. Annual average rainfall at Port Area, Science Garden, NAIA and Napindan stations are calculated at 2,171 mm, 2,483 mm, 1,836 mm and 2,050 mm, respectively. Over the study area, annual average rainfall is calculated at 2,125 mm. Even though, a straight line fitting of the data shows an increasing tendency in annual total rainfall over the study area, but considering the short period of data, it can not be told whether the tendency is for a long period or not. Large annual total rainfall over the study area occurred in 1972 (3,373 mm), 1986 (3,204 mm) and 2000 (3,504 mm).

(2) Monthly Rainfall

Variation in average monthly rainfall at Port Area, Science Garden and NAIA stations averaged over the period 1961-2003 and at Napindan station averaged over the period 2002-2003 is shown in *Figure B.2.3.* Shape of the rainfall histogram at NAIA is different from the other three stations due to short period of data. *Figure B.2.3* also shows average monthly rainfall over the study area as calculated using Thiessen Polygons. Maximum rainfall over the study area occurs in the month of July (475 mm) and then in the month of August (425 mm). It can be seen that 81% of the annual total rainfall over the study area falls during the months of June to October, which can be called as Wet Season.

(3) Monthly Pan Evaporation

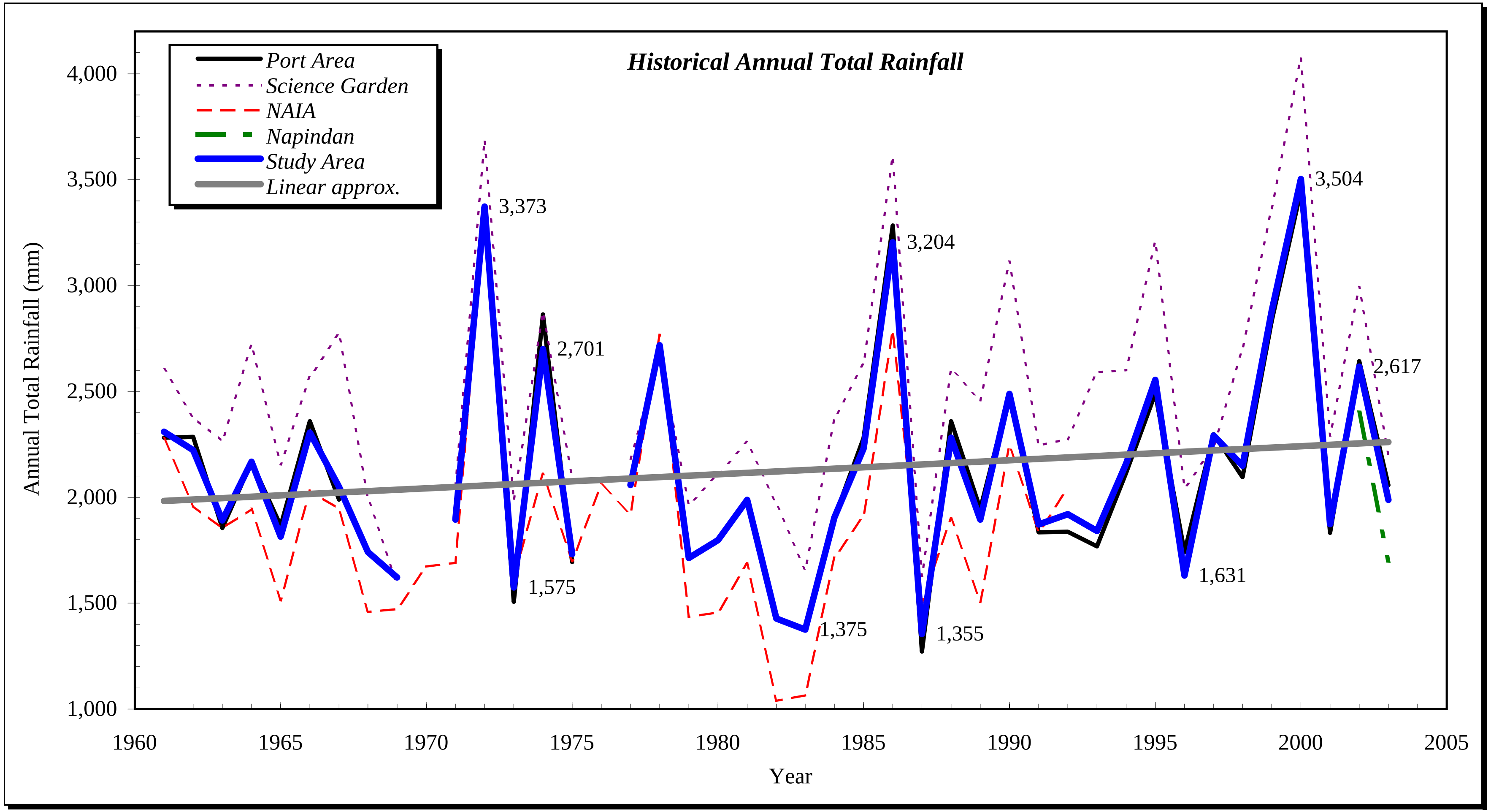
Daily pan evaporation is measured only at Science Garden Station. Variation in average monthly pan evaporation at Science Garden station over the period 1971-2003 is shown in *Figure B.2.3* Mean annual total pan evaporation at Science Garden is calculated at 1,334 mm. Maximum pan evaporation occurs in the month of April (162 mm) and then in the months of May (148 mm) and March (147 mm).

(4) Monthly Temperature

Variation in monthly minimum, average and maximum temperature at Port Area, Science Garden and NAIA stations as well as in the study area (as calculated using Thiessen Polygons) averaged over the period 1961-2003 is shown in *Figure B.2.4.* In the study area, average monthly minimum and maximum temperatures are observed in the months of January (22°C) and April (34°C), respectively. Annual average temperature in the study area is calculated at 28°C with small monthly variation.

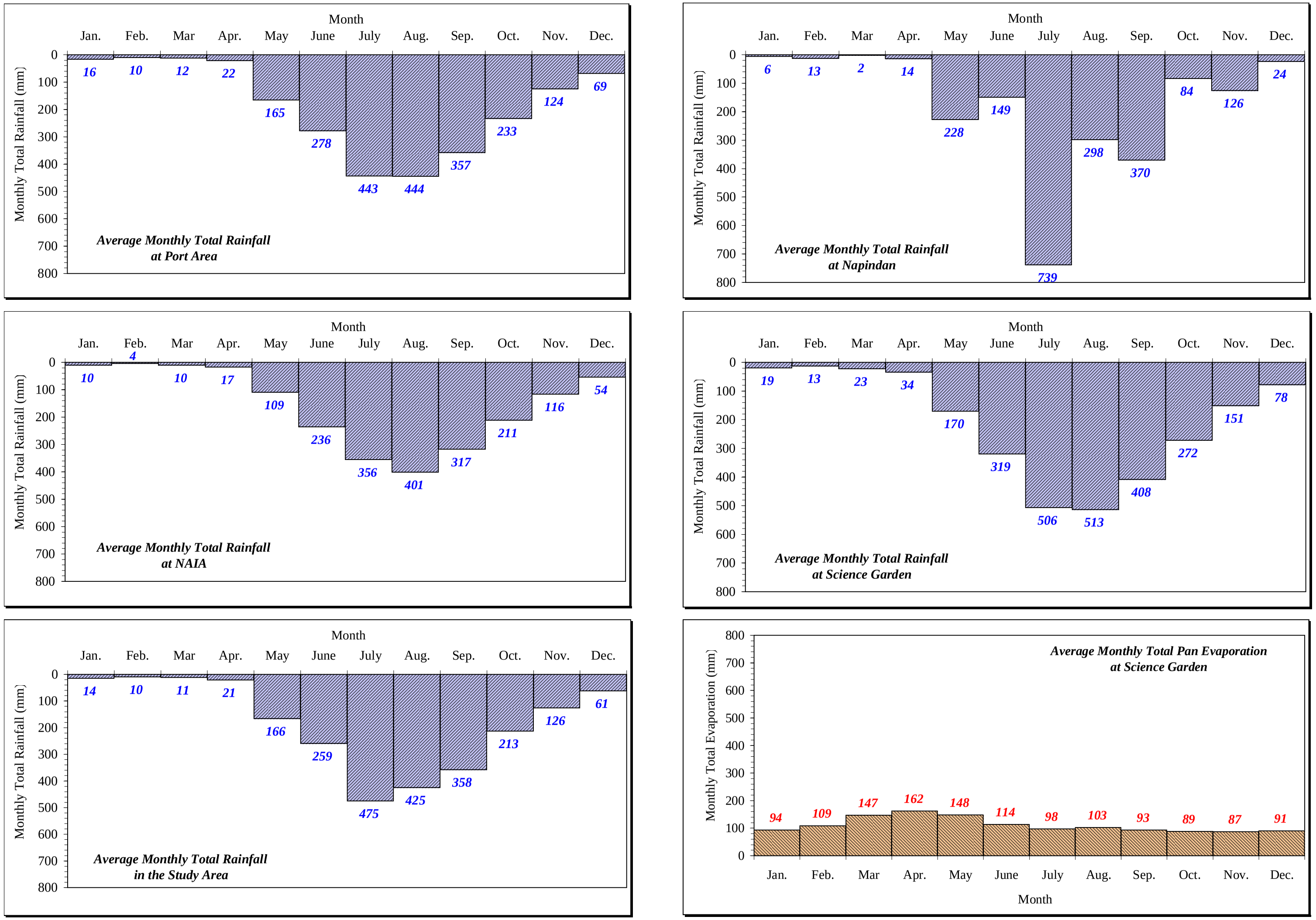
(5) Monthly Relative Humidity

Variation in monthly average relative humidity at Port Area, Science Garden and NAIA stations as well as in the study area (as calculated using Thiessen Polygons) averaged over the period 1961-2003 is shown in *Figure B.2.4.* In the study area, average monthly minimum and maximum relative humidity are observed in the months of March-April (65%) and August-September (80%), respectively. Annual average relative humidity in the Study Area is calculated at 74%.



Source: PAGASA/CAB/CDS and EFCOS
Study Area: Based on Thiessen Polygon Method

Figure B.2.2 Historical Variation in Annual Total Rainfall

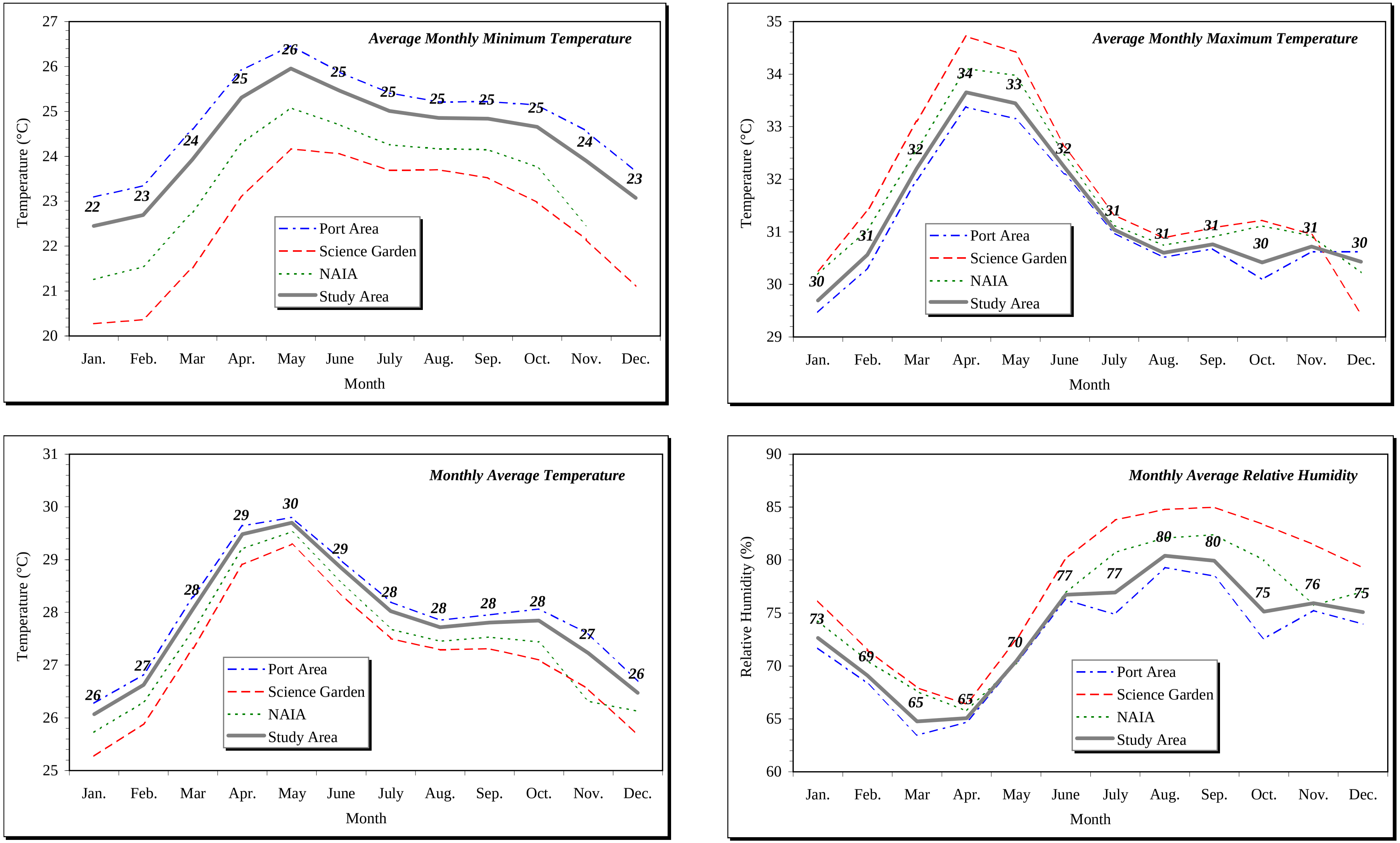


Period: Port Area, Science Garden and NAIA are for period 1961-2003; Napindan is for period 2002-2003

Period: 1971-2003

Source: PAGASA/CAB/CDS and EFCOS
Study Area: Based on Thiessen Polygons

Figure B.2.3 Monthly Variation in Rainfall and Evaporation



Period: 1961-2003

Source: PAGASA/CAB/CDS
Study Area: Based on Thiessen Polygons

Figure B.2.4 Monthly Variation in Temperature and Relative Humidity

(6) Tide Level at Manila Bay

Daily variation in tide level at Manila South Harbor for year 1999 is shown in *Figure B.2.5*. It can be seen that highest tides occur in the months of July-September. Monthly variation in Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) for the period 1999-2003 is shown in *Figure B.2.6*. High levels of MHHW are observed in the months of July (EL. 11.12 m), August (EL. 11.14 m) and September (EL. 11.11 m). Difference between MHHW and MLLW by month varies between 0.89 m to 1.05 m.

There exist calculated mean tide levels at Manila South Harbor for two series of tide cycles of 19-year periods, which are 1970-1988 series and 1901-1919 series. Mean tide values for the two series are presented in *Table B.2.3*. It can be seen that the two different series produced the same mean tide values except Mean High Spring Tide (MHST) which was calculated as EL. 11.34 m for 1970-1988 series and EL. 11.30 m for 1901-1919 series. In order to check whether there is any change in tide levels in recent years compared with the previous two tide series, NAMRIA tide data for period 1999-2003 has been analyzed during this Study. As shown in the last column in *Table B.2.3*, MLLW and MHHW for the period 1999-2003 is calculated to be EL. 10.01 and EL. 10.98 m, respectively which matches well with the previous values of the two tide series. Therefore, the mean tide values of the past two tide series are equally applicable for the present study.

Historical maximum and minimum tide levels at Manila South Harbor are presented in *Table 2.1.5.* The values have been extracted from the previous study reports and have been updated by the collected tide data during this Study. According to the data of the years in *Table B.2.4* historical maximum (EL. 11.91 m) and minimum (EL. 9.33m) tide levels were observed in July 12, 1972 and February 3, 1913, respectively.

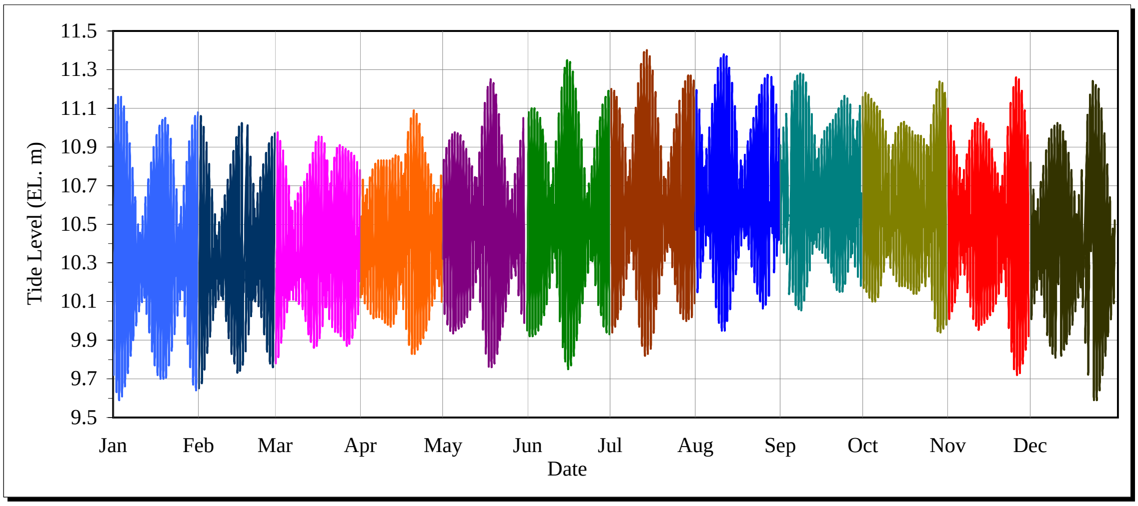
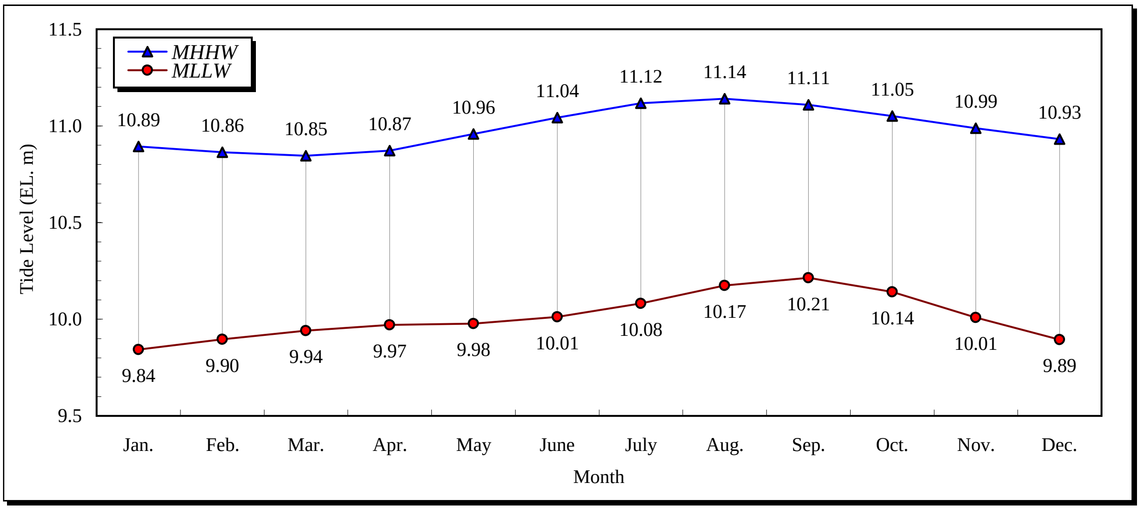


Figure B.2.5 Daily Variation in Tide Level at Manila South Harbor for Year 1999



Datum: DPWH

Period: 1999-2003

Source: NAMRIA

Figure B.2.6 Monthly Variation in MHHW and MLLW at Manila South Harbor

Table B.2.3 Tide Levels at Manila South Harbor for Different Tide Series

Datum: DPWH

Series	Tide Levels (EL. m)			
	1970-1988[1)] (19 Years)	1901-1919[2)] (19 Years)	1984-1987[3)]	1999-2003 (This Study)
MLLW	10.00	10.00		10.01
MLW	10.10	10.10		
MHLW	10.20	10.20		
MSL	10.47	10.47		
MTL (MHW+MLW)/2	10.48	10.48		
MLHW	10.71	10.71		
MHW	10.86	10.86		
MHHW	11.00	11.01		10.98
MHST	11.34	11.30	11.25	
MR (MHW - MLW)	0.76	0.76		

Source: 1) DPWH, The Study on Flood Control and Drainage System Improvement for Kalookan-Malabon-Navotas-Valenzuela (KAMANAVA) Areas, 1998

2) MPWH, Metro Manila Drainage System Rehabilitation Project (PH-66), Drainage Improvement Plans for Estero de Vitas and Other Catchment Areas, Supplementary Study Report, 1987

3) MPWH, Metro Manila Drainage System Rehabilitation Project, Study Report, 1988

Definitions of Terms:
MLLW = Mean Lower Low Water: Average of 1st low (lowest) water levels of a tidal day
MLW = Mean Low Water: Average of the maximum height reached by each rising tide
MHLW = Mean Higher Low Water: Average of 2nd low water levels of a tidal day
MSL = Mean Sea Level: The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings
MTL = Mean Tide Level: A plane midway between Mean High Water and Mean Low Water
MLHW = Mean Lower High Water: Average of 2nd low water levels of a tidal day
MHW = Mean High Water: Average of the minimum height reached by each falling tide
MHST = Mean High Spring Tide: Average of monthly 1st and 2nd high water levels (spring tides occuring at full and new moon SYZYGY)
MHHW = Mean Higher High Water: Average of 1st high (highest) water levels of a tidal day
MR = Mean Range: Difference in height between daily Mean High and Low Water

Table B.2.4 Historical Maximum and Minimum Tide Levels at Manila South Harbor

Datum: DPWH

Year	Highest Tide			Lowest Tide			
	Level (EL. m)	Date(s) Date 1	Date 2	Level (EL. m)	Date(s) Date 1	Date 2	Date 3
1911	11.77	July 23					
1913				9.33	February 3		
1972	11.91	July 12					
1978	11.48	October 12					
1979	11.44	August 9					
1980	11.36	August 27	August 28				
1981	11.51	July 4	August 1				
1982	11.60	June 24					
1983	11.68	August 11					
1984	11.76	August 27	August 29				
1985	11.79	June 22					
1986	11.68	July 9					
1987	11.62	July 12	July 13				
1988	11.65	July 30					
1989	11.61	June 5					
1990	11.59	June 24	June 25				
1991	11.72	October 27					
1992	11.72	August 29					
1993	11.66	October 6					
1994	11.67	June 23	July 10				
1995	11.70	October 1					
1996	11.86	July 31					
1997	11.71	August 18					
1998							
1999	11.40	July 14		9.59	January 3	December 14	December 25
2000	11.47	July 31	August 1	9.55	January 21	January 22	
2001	11.49	July 22	August 19	9.51	January 11		
2002	11.46	August 9	August 10	9.51	January 29		
2003	11.45	July 14		9.49	December 25		

Source: KAMANAVA 1998, PEA 1995, NAMRIA

B.3 METEO-HYDROLOGICAL ANALYSIS

B.3.1 PROBABLE RAINFALL

Historical annual maximum short duration rainfalls at Port Area, Science Garden and NAIA stations are presented in *Table B.3.1*, *Table B.3.2* and *Table B.3.3*, respectively. Data have been collected from PAGASA central office (6-hour interval cylindrical data), Flood Forecasting and Warning Center of PAGASA (short duration chart data) and also have been extracted from previous study reports. Therefore, all the available historical extreme rainfall event data have been utilized for probability analyses.

There are two popular theoretical distribution methods for probability analysis: Gumbel's or Extreme Value Type I distribution method used as a standard method for flood frequency (extreme value) analysis by the U.K. Natural Environmental Research Council and Log-Pearson Type III distribution method used as a standard by U.S. Federal Agencies. There is no demarcation which method produces better result. In terms of analysis, Log-Pearson Type III method requires one empirical parameter called Map Skew Coefficient to account for adjustment of sample size and is available for different states of the U.S. but not available for other places in the world, whereas in Gumbel's method there is no such empirical parameter. In case of the Philippines, Flood Forecasting Center of PAGASA applies Gumbel's method for calculating probable rainfalls to construct Rainfall-Intensity-Duration-Frequency (RIDF) curves and many of the previous studies have also applied Gumbel's method for probability analysis of annual maximum rainfalls at Port Area and NAIA. Therefore, in this Study, probability analysis has been carried out applying Gumbel's method. The goodness of fit has been checked using the Thomas Plotting Position formula which is quite popular all over the world. It is noted during the analyses that, for annual maximum rainfalls up to 24 hours, the theoretical distributions (both Gumbel's and Log-Pearson Type III) fit quite well with the Plotting Positions but for annual maximum 48-hour and 72-hour rainfalls events. The theoretical distributions sometimes fit well with the Plotting Positions and sometimes don't (depending upon the data) due to the fact that, as the rainfall duration becomes large, the rainfall events deviate from the extreme value type. However, considering long range of data, the results of probability analyses for long duration rainfalls are considered to be acceptable. Sample graphs of Gumbel's (theoretical) probability distribution along with Thomas Plot are shown in *Figure B.3.1*

The results of probability are summarized in *Table B.3.4*. The 60-minute probable rainfall depth for 10-year return period is estimated to be 81, 92 and 94 mm at Port Area, Science Garden and NAIA rainfall stations, respectively. The 24-hr probable rainfall depth for 10-year return period is estimated to be 260, 267 and 287 mm at Port Area, Science Garden and NAIA stations, respectively. No general agreement could be found among the stations in terms of producing probable rainfalls for different duration and return periods.

A comparison has been made between probable rainfall depths estimated during this Study and those reported in previous studies, which is summarized in *Table B.3.5*. As can be seen, MPWH Study in 1984 reported the maximum values of probable rainfall depths as calculated with adjustment of the original rainfall data by multiplication factor of >1.0 to account for different uncertainties in measured rainfall data. The table shows that probable rainfall depths calculated by this Study is consistent with the previous studies, especially with the most recent FCSEC estimation.

Table B.3.1 Annual Maximum Rainfall at Port Area Station

Unit: mm

Year / Rain	Minutes 10 (mm)	20 (mm)	30 (mm)	60 (mm)	Hours 2 (mm)	3 (mm)	6 (mm)	12 (mm)	24 (mm)	48 (mm)	72 (mm)
1903									78.7	92.0	105.9
1904									226.2	423.7	475.9
1905									-	-	-
1906									144.9	163.3	171.8
1907	15.2		40.0	57.3	72.4				141.9	201.2	217.8
1908	16.7		37.6	57.3	61.6				121.6	165.3	211.9
1909	28.7		43.1	46.7	-				88.7	152.0	200.8
1910	13.2		30.7	40.6	-				69.6	89.8	121.9
1911	15.2		27.2	43.9	-				133.1	179.4	221.4
1912	20.3		36.1	45.6	-				157.6	233.3	309.2
1913	23.1		49.5	60.7	62.0				128.2	234.0	278.9
1914	17.9		39.9	46.3	-				234.7	404.2	518.7
1915	15.2		32.5	41.6	-				105.4	144.9	200.8
1916	16.2		30.5	40.7	-				74.2	91.3	126.8
1917	23.4		43.5	44.8	-				107.6	141.0	168.8
1918	19.5		42.2	55.3	-				271.5	371.1	383.0
1919	20.1		41.6	49.8	80.0				310.6	511.0	566.5
1920	18.3		32.1	41.8	-				85.0	-	-
1921	17.3		40.7	58.7	71.4				263.6	400.9	491.1
1922	13.5		20.7	-	-				104.2	-	-
1923	16.6		36.6	54.2	70.0				309.1	556.0	592.1
1924	16.9		40.9	68.8	116.4				285.0	325.8	370.9
1925	13.2		28.9	32.6	-				130.7	225.5	237.5
1926	16.5		32.3	35.5	-				139.1	163.2	277.8
1927	19.6		36.8	63.0	73.6				103.9	142.8	189.4
1928	16.0		25.7	36.6	-				85.6	147.6	171.1
1929	21.1		49.8	65.0	67.6				121.9	166.7	207.6
1930	17.3		26.1	-	-				153.6	242.0	264.3
1931	24.1		59.2	65.8	82.6				265.7	529.0	730.2
1932	21.1		58.7	100.9	160.4				203.2	234.2	299.2
1933	15.0		28.7	32.0	-				116.6	187.2	267.4
1934	19.6		47.5	76.9	105.8				186.7	-	-
1935	21.0		48.2	65.8	95.2				149.5	-	-
1936	22.6		48.0	59.2	61.2				136.7	-	-
1937	19.3		45.2	63.6	70.6				143.3	-	-
1938	16.8		30.6	50.1	69.8				216.9	297.9	350.0
1939	14.2		27.7	-	-				177.8	-	-
1949	11.6	17.6	21.7	28.0	40.1	47.9	60.8	74.5	83.3	90.9	111.2
1950	22.4	31.5	40.6	43.2	50.8	50.8	66.3	75.7	105.4	121.7	141.5
1951	23.6	38.9	43.4	45.2	55.4	56.4	65.3	88.6	99.1	122.7	177.9
1952	34.3	56.9	76.7	92.5	97.5	118.6	210.1	284.1	292.9	-	-
1953	22.9	40.1	53.8	72.9	111.0	127.0	166.9	205.7	208.0	-	-
1954	37.6	52.6	58.9	82.3	108.7	108.7	108.7	108.7	108.7	147.5	205.2
1955	23.3	32.0	41.8	54.6	77.9	96.7	136.2	161.2	177.3	118.6	118.9
1956	26.4	33.8	42.9	74.4	108.0	122.7	152.9	169.4	185.9	252.7	294.6
1957	21.1	30.5	44.5	58.9	61.2	73.4	96.0	109.5	132.3	178.5	200.9
1958	24.1	40.9	46.7	63.5	87.4	94.0	116.1	179.6	239.8	414.8	515.1
1959	14.0	22.4	32.5	52.1	74.2	90.7	123.7	128.5	130.6	156.8	160.4
1960	26.4	43.7	46.7	51.3	71.1	91.9	128.5	164.1	218.2	271.8	312.7
1961	18.0	31.2	38.6	54.9	87.6	100.3	132.8	191.3	236.2	331.2	-
1962	22.8	35.0	44.0	59.6	87.1	105.5	140.1	171.0	195.8	277.2	346.0
1963	15.2	23.4	30.4	59.2	99.2	105.5	109.6	109.6	116.1	192.6	173.2
1964	26.5	38.6	46.5	55.6	64.6	72.2	97.0	150.3	202.9	226.0	211.3
1965	33.8	47.6	71.4	90.5	97.2	97.2	98.8	109.0	116.4	166.5	170.8
1966	20.6	35.0	49.2	74.1	76.2	79.4	108.8	141.5	143.6	285.7	-
1967	18.6	32.8	42.9	72.0	98.6	103.3	146.0	198.2	213.2	251.0	299.4
1968	23.0	33.8	34.7	55.4	57.7	57.7	70.8	98.0	106.6	143.2	153.8
1969	15.1	23.2	31.9	49.0	54.5	56.5	74.4	90.6	103.4	154.4	170.5
1970	49.8	76.4	95.6	126.7	184.2	221.9	289.9	355.8	403.1	508.8	654.4
1971	16.3	26.6	39.9	67.0	93.0	95.6	95.6	99.1	99.1	99.1	123.9
1972	30.2	45.7	57.0	77.4	115.4	140.9	186.3	227.5	265.4	487.9	709.9
1973	21.1	32.9	41.0	59.5	59.7	59.7	61.5	77.5	91.4	124.3	116.8
1974	24.8	34.5	48.4	57.4	82.9	100.0	131.8	159.4	182.2	292.5	-
1975	13.9	21.3	26.9	36.8	54.1	65.7	88.0	107.4	123.4	129.5	181.8
1976	41.8	64.1	80.1	105.9	153.8	185.1	241.4	296.3	335.4	383.7	400.9
1977	29.5	45.3	56.5	74.5	108.1	130.0	168.9	207.5	234.4	310.9	374.8
1978	33.0	49.9	62.3	82.8	119.4	143.5	186.8	226.5	257.4	429.7	536.3
1979										207.0	-
1980										124.4	-
1981	20.0	27.5	33.0	40.0	55.8	57.5	77.0	90.6	103.2	152.7	184.1
1982	13.7	21.1	26.4	34.8	50.5	60.8	79.3	97.4	110.2	157.0	174.4
1983	10.1	15.3	18.8	24.3	34.3	40.8	51.7	62.6	70.0	110.9	144.7
1984	19.3	27.6	33.4	45.4	54.0	56.1	60.6	65.6	81.2	139.8	181.0
1985	29.7	45.5	57.2	77.2	112.8	136.5	180.9	221.3	252.8	387.1	-
1986	27.4	41.9	52.1	68.2	98.3	117.8	152.3	186.8	210.5	359.7	379.5
1987	19.8	27.4	30.1	35.2	53.5	56.7	63.4	85.2	88.7	117.5	135.7
1988	14.9	22.8	28.6	38.2	55.5	67.0	88.1	107.7	122.7	235.2	243.0
1989	20.3	22.9	28.3	38.1	54.9	66.9	89.8	110.8	127.5	180.7	233.3
1990	18.7	27.0	32.1	49.7	77.8	102.9	160.1	193.8	201.1	266.9	290.0
1991	24.1	36.5	46.1	62.6	84.8	97.0	125.5	154.5	174.8	253.7	263.1
1992	16.9	25.5	32.3	43.7	59.3	67.8	87.7	108.0	122.2	136.3	177.6
1993	11.5	17.4	22.0	29.9	40.4	46.3	59.9	73.7	83.4	113.7	134.4
1994	16.2	24.5	30.9	42.0	56.8	65.0	84.1	103.6	117.2	186.4	188.8
1995	18.7	28.3	35.7	48.5	65.7	75.1	97.2	119.7	135.4	188.2	211.1
1996	14.5	22.0	27.8	37.7	51.1	58.5	75.7	93.2	105.4	181.8	213.6
1997	33.3	50.5	63.8	86.5	117.1	134.0	173.4	213.5	241.5	402.0	425.0
1998	16.1	24.3	30.7	41.7	56.5	64.6	83.6	102.9	128.8	210.6	274.0
1999	26.3	39.8	50.3	68.2	92.3	105.7	136.7	168.3	190.4	353.6	421.0
2000	24.5	37.1	46.9	63.5	86.1	98.5	127.4	156.9	177.5	255.7	316.4
2001							-	-	-	-	-
2002							119.6	201.6	342.6	448.8	513.6
2003							111.0	116.0	178.6	238.1	318.5
Maximum	49.8		95.6	126.7	184.2		289.9	355.8	403.1	556.0	730.2
Minimum	10.1		18.8	24.3	34.3		51.7	62.6	69.6	89.8	105.9
Mean	21.0		41.4	56.9	80.5		118.2	146.2	165.3	238.2	280.2
Std. Dev.	7.0		13.8	18.8	28.7		49.5	63.4	72.7	119.4	148.6
Skew Coeff.	1.5		1.3	1.0	1.2		1.2	1.1	0.9	0.9	1.3
Sample (n)	83		83	80	66		52	52	88	81	75

Source:

For period 1903-1939:
data have been extracted from
"Metro Manila Integrated Urban
Drainage and Flood Control Master Plan,
Ministry of Public Works and Highways, 1984"

For 10-min, 20-min, 30-min, 60-min, 2-hr, 3-hr,
6-hr, 12-hr and 24-hr rainfalls
for period 1949-2000: Flood Forecasting
& Warning Center, PAGASA

For 6-hr, 12-hr, 24-hr, 48-hr and 72-hr rainfalls
for period 1982-2003:
6-hourly data from PAGASA Central Office

Data for 48-hr and 72-hr rainfalls during
period 1903-1981 have been extracted from
"Metro Manila Integrated Urban
Drainage and Flood Control Master Plan,
Ministry of Public Works and Highways, 1984"

Some data for 48-hr rainfalls during period
1949-1981 have been extracted from
"The Study on Flood Control and
Drainage System Improvement for
Kalookan-Malabon-Navotas-Valenzuela
(KAMANAVA) Areas,
Department of Public Works and Highways, 1998"

Table B.3.2 Annual Maximum Rainfall at Science Garden Station

Unit: mm

Year / Rain	Minutes				Hours						
	10 (mm)	20 (mm)	30 (mm)	60 (mm)	2 (mm)	3 (mm)	6 (mm)	12 (mm)	24 (mm)	48 (mm)	72 (mm)
1961							177.8	213.1	251.0	280.2	322.8
1962							135.6	173.7	205.0	327.9	396.0
1963							71.6	125.0	167.1	178.3	211.3
1964							99.1	104.1	198.3	259.5	272.2
1965	20.1	30.6	38.3	50.8	73.3	88.2	115.3	140.8	159.8	239.3	239.3
1966	25.6	38.8	47.8	60.0	85.1	100.7	125.1	153.9	169.9	274.3	316.7
1967	39.5	60.4	75.9	102.4	149.6	181.0	239.7	292.8	334.5	350.0	357.6
1968	17.9	27.4	34.2	45.6	66.1	79.6	104.7	127.9	145.5	205.0	209.6
1969	15.4	23.6	29.5	38.9	56.4	67.8	88.4	108.6	122.8	397.3	406.1
1970	31.9	48.8	61.5	83.7	122.4	148.4	197.7	241.0	276.5	-	-
1971	22.5	30.1	33.8	46.2	54.7	57.9	74.4	80.5	84.6	103.7	185.0
1972	19.8	27.9	41.8	72.5	122.5	143.5	158.5	159.8	218.0	435.2	682.1
1973	33.6	64.2	86.6	130.3	130.8	131.3	131.3	131.3	131.3	298.1	300.9
1974	16.8	25.9	32.6	42.2	77.5	102.6	149.4	180.8	214.3	366.3	440.4
1975	14.0	22.5	26.0	31.7	48.9	68.0	104.9	170.1	209.3	247.7	285.3
1976	50.0	76.8	96.2	128.0	186.3	224.7	294.5	361.2	410.1	-	-
1977	16.7	25.4	30.5	39.3	58.5	71.5	90.3	116.3	135.7	-	-
1978	19.2	29.4	37.0	47.2	68.1	81.3	103.8	148.2	174.4	255.5	319.2
1979	23.4	40.6	51.5	67.1	86.9	130.3	179.3	191.7	223.0	297.9	348.2
1980	21.7	32.1	38.0	46.0	70.4	77.4	102.7	123.6	133.8	147.5	220.7
1981	30.7	30.7	30.9	37.5	50.0	52.4	73.0	115.7	161.0	230.9	249.7
1982	17.9	27.1	33.3	42.2	60.1	71.2	89.1	109.8	121.6	144.2	170.4
1983	13.6	20.8	26.2	35.2	51.3	62.0	82.0	100.2	114.4	131.2	154.2
1984	14.5	22.2	27.5	35.4	50.9	60.8	77.4	95.4	106.6		
1985	16.6	25.1	31.5	41.8	60.3	72.6	95.1	116.0	131.0	-	-
1986	22.1	34.2	43.5	72.2	122.7	150.7	176.1	184.9	190.4	367.5	434.3
1987	16.4	24.9	31.2	42.4	62.0	74.7	99.0	120.1	137.6	142.0	176.0
1988	15.1	22.8	28.5	38.5	55.6	67.2	88.9	107.7	123.1	240.5	300.3
1989	13.4	19.7	24.4	32.4	45.8	54.5	70.4	85.2	96.4	175.4	217.7
1990	25.3	38.6	48.1	63.7	91.9	110.4	143.8	176.0	199.4	233.6	250.6
1991							157.8	194.2	253.5	295.5	304.1
1992							81.2	101.0	145.2	177.6	233.8
1993							112.6	138.6	151.9	209.4	223.6
1994							106.6	145.8	169.8	196.4	213.0
1995							72.0	106.0	163.6	169.8	202.4
1996							81.2	94.2	120.2	155.0	169.2
1997							104.2	191.8	223.8	301.2	324.1
1998							89.8	108.7	172.7	241.5	292.5
1999							191.7	204.8	280.7	431.3	532.9
2000							181.4	260.2	267.0	319.2	405.1
2001							88.0	105.0	129.4	209.7	235.7
2002							80.6	152.4	216.3	417.9	494.3
2003							73.2	99.0	156.0	278.6	363.6
Maximum							294.5	361.2	410.1	435.2	682.1
Minumum							70.4	80.5	84.6	103.7	154.2
Mean							120.0	150.2	181.3	256.1	301.6
Std. Dev.							49.9	58.6	65.8	87.8	113.0
Skew Coeff.							1.5	1.6	1.3	0.4	1.3
Sample (n)	26	26	26	26	26	26	43	43	43	38	38

Source: For 10-min, 20-min, 30-min, 60-min, 2-hr, 3-hr, 6-hr, 12-hr and 24-hr rainfalls for period 1965-1990: Flood Forecasting & Warning Center, PAGASA

The rest of the data: 6-hourly data from PAGASA Central Office

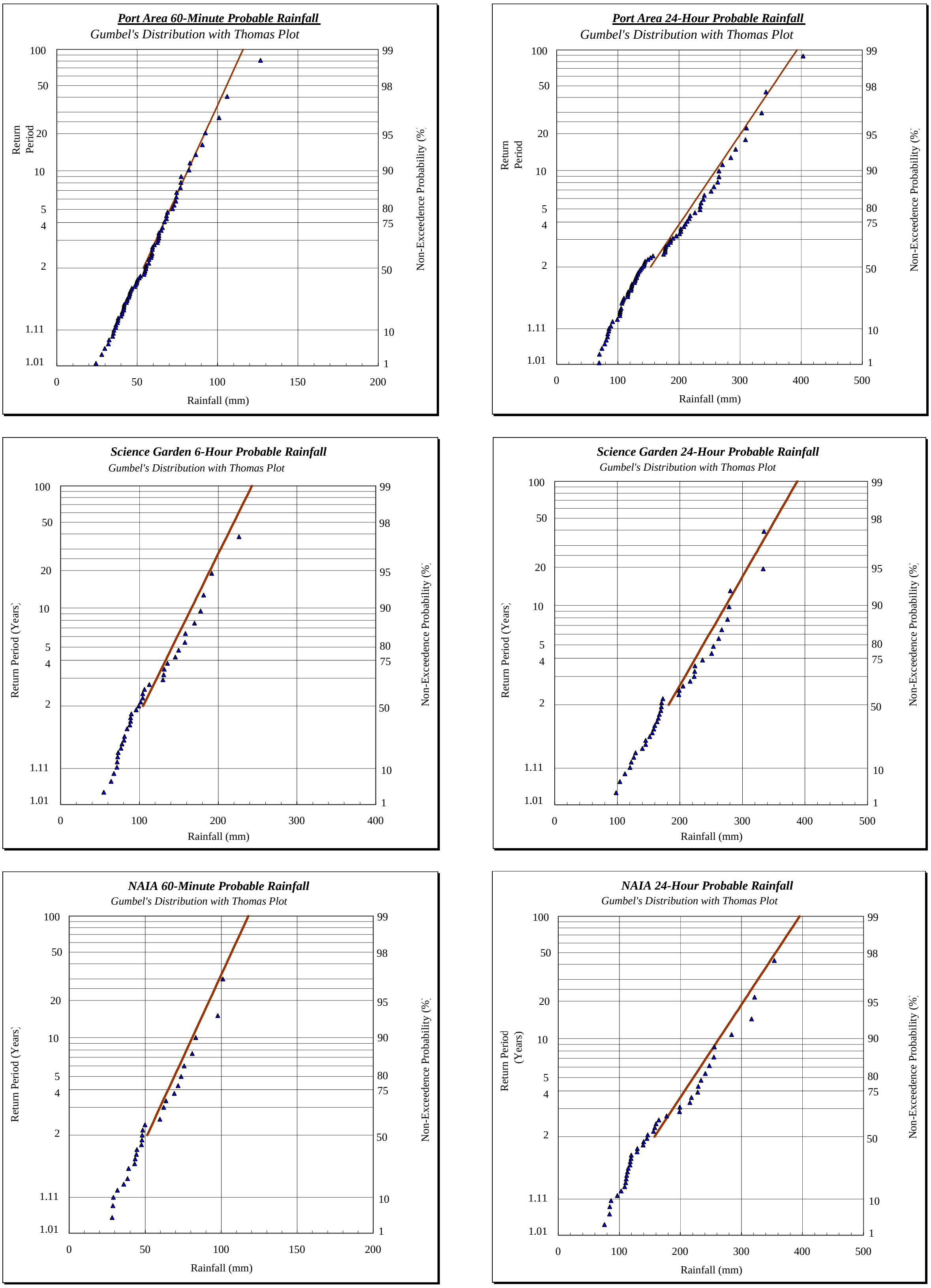
Table B.3.3 Annual Maximum Rainfall at NAIA Station

Unit: mm

Year / Rain	Minutes				Hours						
	10 (mm)	20 (mm)	30 (mm)	60 (mm)	2 (mm)	3 (mm)	6 (mm)	12 (mm)	24 (mm)	48 (mm)	72 (mm)
1949	10.9	16.7	20.9	27.5	40.0	48.0	62.4	76.6	86.6		
1950	12.5	19.1	24.1	33.0	48.4	58.8	78.8	96.1	110.5		
1951	19.1	33.8	47.2	73.7	80.8	81.5	84.3	84.3	84.3		
1952	24.4	37.8	41.9	44.2	64.9	85.3	147.8	217.4	228.6		
1953	22.1	39.9	49.0	69.1	92.2	106.4	118.6	127.0	140.0		
1954	26.2	35.1	38.4	49.8	66.5	77.5	77.5	97.8	117.9		
1955	17.8	24.9	27.9	28.7	38.2	46.1	60.6	73.7	84.1		
1956	21.1	30.5	42.7	59.7	69.4	86.1	118.4	137.2	146.6		
1957	14.8	22.7	28.4	37.5	54.5	65.7	85.7	105.2	119.1		
1958	45.0	68.9	86.0	113.0	163.8	196.7	255.2	313.5	353.8		
1959	12.8	19.6	24.7	33.7	49.3	59.9	79.8	97.1	111.5		
1960	20.3	34.3	44.7	75.7	90.2	95.3	122.2	172.2	229.1		
1961	28.4	43.6	54.4	71.6	103.9	124.9	162.3	199.4	225.3	305.1	342.9
1962	19.6	32.8	39.4	48.3	61.0	87.9	115.8	136.1	166.1	302.3	319.8
1963	29.9	44.2	59.0	81.0	118.7	135.6	166.0	196.8	228.9	379.2	439.7
1964	20.7	36.5	47.2	62.1	76.6	92.0	121.1	218.2	277.9	160.0	162.1
1965	17.2	32.8	38.5	48.1	54.2	57.4	58.5	58.9	65.3	123.0	129.8
1966	22.8	38.6	45.2	47.9	49.5	61.6	91.0	127.5	145.3	263.1	376.4
1967	26.9	35.5	35.5	43.4	58.7	66.3	91.8	137.0	149.4	199.6	210.6
1968	33.3	54.6	71.3	101.1	110.7	113.8	113.8	113.8	114.5	194.3	220.2
1969	19.3	27.7	34.7	43.0	48.4	50.4	65.6	78.4	80.0	126.2	153.8
1970	19.0	30.0	41.0	47.5	65.0	83.0	118.5	137.0	198.5	291.5	466.0
1971	15.6	27.3	33.9	44.5	66.0	70.1	98.5	109.0	119.0	131.8	193.0
1972	63.5	97.4	120.7	156.0	224.6	268.4	342.8	422.3	472.4	763.3	902.0
1973	12.3	19.7	20.8	28.2	41.3	50.5	72.7	115.1	129.0	148.8	158.2
1974	13.8	22.5	22.5	35.9	48.5	49.5	64.0	113.4	144.1	216.2	257.4
1975	21.8	30.3	43.7	63.7	75.6	113.4	170.1	210.6	218.3	234.8	263.1
1976	24.3	36.7	45.5	59.7	85.3	101.8	177.0	192.4	256.0	321.1	359.3
1977	25.1	38.0	47.4	63.2	91.3	109.7	143.2	174.3	199.0	278.5	317.5
1978	31.9	49.0	61.5	83.3	121.7	147.3	195.6	239.0	274.5	323.6	350.4
1979	18.5	23.9	31.1	39.0	63.8	78.1	96.1	102.9	104.0	262.7	290.0
1980	15.1	19.4	25.4	31.8	39.9	47.8	62.9	76.1	87.0	148.8	153.0
1981	15.1	22.7	27.5	29.1	46.7	47.8	50.7	68.5	76.4	137.0	150.7
1982	17.6	32.3	34.2	35.3	45.7	46.7	66.8	68.3	69.4	158.4	170.8
1983	15.1	23.2	29.0	38.4	55.9	67.3	87.9	107.9	122.2	126.8	129.2
1984	13.1	16.9	21.3	28.8	41.9	50.7	67.0	81.4	93.2	226.5	238.2
1985	38.8	59.4	74.4	99.0	144.1	173.7	227.5	279.1	316.8	476.6	511.5
1986	37.3	57.6	72.3	97.8	143.2	173.4	230.4	280.3	321.4	482.7	506.7
1987	17.0	28.5	32.5	38.4	38.4	43.0	53.0	94.0	103.0	104.0	149.4
1988	17.9	27.5	34.7	47.4	69.5	84.4	113.0	137.9	158.4	201.8	250.0
1989	20.8	33.8	45.4	85.6	90.2	90.2	90.2	90.2	102.0	131.7	131.7
1990	35.3	54.1	67.5	89.0	129.1	155.1	201.8	247.9	280.2	319.7	329.1
1991	15.1	23.0	29.0	39.5	57.8	70.1	93.5	114.0	130.8	238.9	353.9
Maximum	63.5		120.7	156.0	224.6		342.8	422.3	472.4	763.3	902.0
Minimum	12.3		20.8	28.2	38.2		50.7	58.9	65.3	104.0	129.2
Mean	22.5		43.3	57.5	77.3		118.6	147.1	168.4	250.9	289.9
Std. Dev.	10.1		19.9	27.7	39.3		62.7	77.8	90.2	137.3	161.0
Skew Coeff.	2.0		1.8	1.4	1.7		1.6	1.5	1.3	2.0	2.0
Sample (n)	43	43	43	43	43	43	43	43	43	31	31

Source: For 10-min, 20-min, 30-min, 60-min, 2-hr, 3-hr, 6-hr, 12-hr and 24-hr rainfalls for period 1949-1991: Flood Forecasting & Warning Center, PAGASA

The rest of the data: 6-hourly data from PAGASA Central Office



Source: Calculated by this Study

Figure B.3.1 Probable Rainfall Depths by Return Periods

Table B.3.4 Results of Probability Analyses on Annual Maximum Rainfalls

Port Area

Unit: mm

Return Period (Years)	Probable Rainfall Depth (mm)								
	Minutes			Hours					
	10	30	60	2	6	12	24	48	72
2	19.85	39.09	53.83	75.80	110.05	135.74	153.35	218.60	255.77
3	22.76	44.86	61.69	87.82	130.74	162.23	183.74	268.49	317.91
5	26.01	51.29	70.44	101.21	153.78	191.74	217.60	324.07	387.12
10	*30.09*	*59.37*	*81.44*	*118.03*	*182.74*	*228.81*	*260.13*	*393.90*	*474.09*
20	34.00	67.12	91.99	134.17	210.51	264.37	300.93	460.89	557.51
30	36.26	71.58	98.06	143.45	226.49	284.83	324.41	499.42	605.51
50	39.07	77.15	105.65	155.05	246.46	310.40	353.75	547.59	665.50
100	42.87	84.67	115.89	170.70	273.40	344.89	393.33	612.57	746.42
Sample (n)	83	83	80	66	52	52	88	81	75

Period: 1903-2003

Science Garden

Unit: mm

Return Period (Years)	Probable Rainfall Depth (mm)								
	Minutes			Hours					
	10	30	60	2	6	12	24	48	72
2	21	39	52	75	108	141	171	242	283
3	24	47	64	90	131	165	198	278	330
5	28	55	76	107	157	192	229	319	383
10	34	66	92	128	189	227	267	371	449
20	39	77	108	149	220	259	304	420	512
30	41	83	117	160	237	278	325	448	549
50	45	90	128	175	260	302	352	484	595
100	50	101	143	195	290	334	388	531	656
Sample (n)	26	26	26	26	43	43	43	38	38

Period: 1961-2003

NAIA

Unit: mm

Return Period (Years)	Probable Rainfall Depth (mm)								
	Minutes			Hours					
	10	30	60	2	6	12	24	48	72
2	21	40	53	71	108	134	163	228	263
3	25	48	65	87	135	167	198	286	331
5	30	58	77	106	164	203	238	350	406
10	36	69	94	129	200	249	287	430	500
20	41	80	109	151	236	292	335	507	590
30	45	87	118	163	256	317	362	551	642
50	49	95	129	179	281	349	396	607	707
100	54	106	144	200	315	391	442	681	795
Sample (n)	43	43	43	43	43	43	43	31	31

Period: 1949-1991

Table B.3.5 Comparison on Estimated Probable Rainfall Depths by Different Studies

1

R = mm/hr; t = minutes

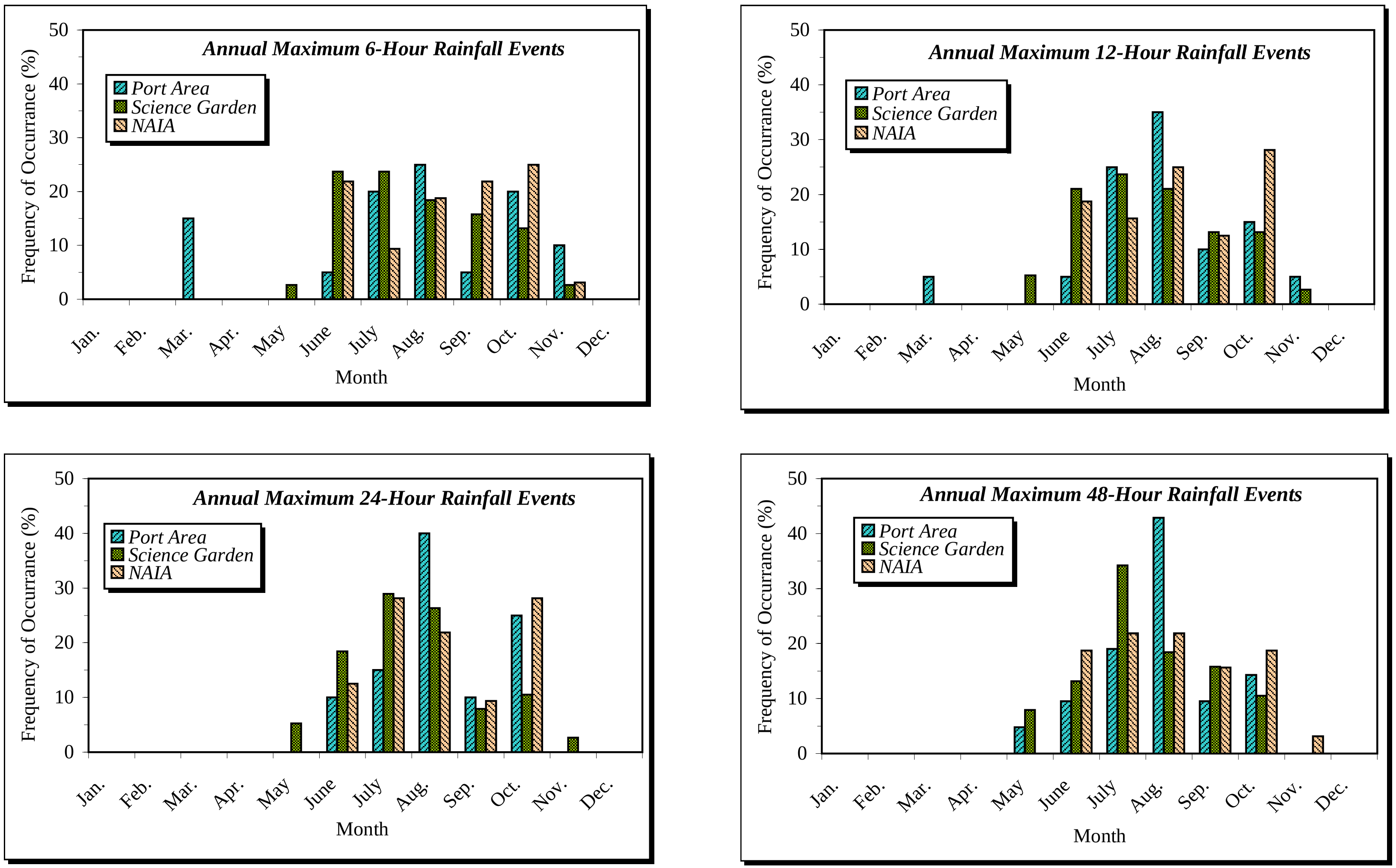
Return Period (Years)	Study Name	Data Used	Method of Probability Analysis	Probable Rainfall Depth (mm)									Equation for Rainfall Intensity - Duration Curve
				Minutes			Hours						
				10	30	60	2	6	12	24	48	72	
2	**This Study, 2004**	**1903-2003**	**Gumbel**	20	39	**54**	76	110	136	*153*	219	256	$R=1,054/(t+14)^{0.69}$
	PAGASA 1981	1950-1975	Gumbel	22	43	**57**	72						$R=1,774/(t+17)^{0.79}$
	MPWH 1984	1907-1974	Log Pearson Type III	27	51	**74**	104						$R=672/(t+5)^{0.53}$
	JICA 1990, JICA 2000	1907-1974	Log-Normal	23	40	**57**	80			*192*	192		$R=434.23/(t)^{0.498}$
	PEA Mar. 1995, DPWH 1998	1949-1990	Gumbel	20	37	**52**	66	94	115	*153*			
	PEA Nov. 1995	1949-1990	Log-Normal	19	37	**51**	65	93	114	*151*			
	FCSEC, 2003	1907-2000	Gumbel			**52**							$R = 4,860.10/(27.70+t^{1.02})$ & $R = 5,426.08/(58.15+t^{0.92})$
5	**This Study, 2004**	**1903-2003**	**Gumbel**	26	51	**70**	101	154	192	*218*	324	387	$R=1,105/(t+11)^{0.64}$
	BPW 1952	1907-1939	Least Square	22	48	**65**	76						$R=19,051/(t+50)^{1.21}$
	BPW 1974, BPW 1978, MPWH 1986, MPWH 1988, DPWH 1990		California	25	49	**70**	98						$R=858.8/(t+10)^{0.59}$
	PAGASA 1981	1950-1975	Gumbel	29	56	**75**	96						$R=2,112/(t+16)^{0.77}$
	MPWH 1984	1907-1974	Log Pearson Type III	31	61	**87**	122						$R=965/(t+8)^{0.57}$
	JICA 1990, JICA 2000	1907-1974	Log-Normal	28	49	**70**	100			*288*	336		$R=5,151.81/(t)^{0.487}$
	PEA Mar. 1995 & DPWH 1998	1949-1990	Gumbel	26	50	**70**	91	135	172	*220*			
	PEA Nov. 1995	1949-1990	Log-Normal	25	49	**67**	87	130	164	*214*			
	FCSEC, 2003	1907-2000	Gumbel			**70**							$R = 16,524.97/(74.85+t^{1.24})$ & $R = 17,502.14/(185.91+t^{1.02})$
10	**This Study, 2004**	**1903-2003**	**Gumbel**	30	59	**81**	118	183	229	*260*	394	474	$R=1,216/(t+11)^{0.63}$
	BPW 1952	1907-1939	Least Square	24	50	**72**	98						$R=1,490/(t+20)^{0.69}$
	BPW 1974, BPW 1978, MPWH 1986, MPWH 1988, DPWH 1990	1907-1972	California	28	53	**77**	112						$R=510.6/(t+1)^{0.46}$
	PAGASA 1981	1950-1975	Gumbel	33	63	**85**	108						$R=2,629(t+17)^{0.79}$
	MPWH 1984	1907-1974	Log Pearson Type III	34	67	**95**	132						$R=1,217/(t+10)^{0.60}$
	JICA 1990, JICA 2000		Log-Normal	31	55	**78**	112			*360*	432		$R=565.36/(t)^{0.483}$
	PEA Mar. 1995 & DPWH 1998	1949-1990	Gumbel	30	59	**82**	108	163	210	*265*			
	PEA Nov. 1995	1949-1990	Log-Normal	29	56	**78**	102	154	198	*252*			
	FCSEC, 2003	1907-2000	Gumbel			**83**							$R = 27,293.72/(107.26+t^{1.32})$ & $R = 6,017.42/(89.62+t)^{0.85}$
20	**This Study, 2004**	**1903-2003**	**Gumbel**	34	67	**92**	134	211	264	*301*	461	558	$R=1,281/(t+10)^{0.61}$
	BPW 1952	1907-1939	Least Square	26	57	**87**	132						$R=615/(t+10)^{0.46}$
	BPW 1974, BPW 1978	1907-1972	California			**90**							$R=3,007/(t+20)^{0.8}$
	PAGASA 1981	1950-1975	Gumbel	37	72	**97**	124						$R=2,733/(t+16)^{0.77}$
	MPWH 1984	1907-1974	Log Pearson Type III	37	74	**106**	146						$R=1,502/(t+12)^{0.62}$
	JICA 1990, JICA 2000	1907-1974	Log-Normal	34	73	**85**	122			*432*	528		
	PEA Mar. 1995, DPWH 1998	1949-1990	Gumbel	34	68	**94**	124	190	246	*307*			
	FCSEC, 2003	1907-2000	Gumbel										

BPW 1952: Plan for the Drainage of Manila and Suburbs, Volume I, 1952
BPW 1974: Technical Report on Engineering Design for Drainage Pumping Stations and Floodgates, 1974
BPW 1978: Technical Report on Engineering Design for Drainage Pumping Stations and Floodgates, 1974
MPWH 1984: Metro Manila Integrated Urban Drainage and Flood Control Master Plan, 1984
(for annual maximum rainfall data of 5 and 10 minutes before 1950, adjustment factors of 1.13 and 1.04 were applied and for the rest of the data up to 120 minutes, adjustment factor of 1.20 was applied)
(for annual maximum rainfall data of >120 minutes but <1-day, adjustment factor of 1.10 was applied and for annual maximum rainfall data of 1, 2 and 3 days, adjustment factor of 1.13, 1.04 and 1.03 were applied)
MPWH 1986: Drainage Improvement Plans of Estero de Vitas and Other Catchment Areas, 1986
MPWH 1988: Metro Manila Drainage System Rehabilitation Project, 1988
DPWH 1990: The Detailed Engineering and Construction Supervision of Metro Manila Flood Control Project (II), 1990
JICA 1990: The Study on Flood Control and Drainage Project in Metro Manila, 1990
PEA Mar. 1995: The Study on the Updated Drainage Plan for the Libertad Reclamation Area in Pasay City, Metro Manila, 1995
PEA Nov. 1995: The Study of and Updated Drainage Plan for Section II of Manila Bay Reclamation Area, Pasay City and Parañaque, Metro Manila, 1995
DPWH 1998: The Study on Flood Control and Drainage System Improvement for Kalookan-Malabon-Navotas-Valenzuela KAMANAVA) Areas, 1998

B.3.2 FREQUENCY HISTOGRAMS OF ANNUAL MAXIMUM RAINFALL EVENTS

In order to grasp the critical month for inundation, analyses on frequency histograms have been carried out. Histograms of occurrences (percentage) of annual maximum rainfall events of 6 hours and longer than 6 hours are shown in *Figure B.3.2* The histograms have been constructed by compiling collected rainfall data of 6 hours interval from PAGASA central office. From *Figure B.3.2*, it is interpreted that most of the historical annual maximum rainfall events occurred in the months of July, August and October at Port Area; in the months of June, July and August at Science Garden and in the months of June, July, August and October at NAIA. Considering that Port Area contributes most of the rainfall in the study area and integrating the combined effect of high rainfall with high tide at Manila Bay (as shown in *Figure B.3.2*), it is inferred that the most possible critical month in terms of inundation is August and the next is July.

In recent years, large inundation occurred in 1999 for which, detailed inundation survey data is available. The meteo-hydrological condition of 1999 inundation has been investigated and the details are explained in *Supporting Report C*.



Period: Port Area from 1982-2003, Science Garden from 1961-2003 and NAIA from 1961-1992

Source: 6-hourly rainfall data from PAGASA/CAB/CDS

Figure B.3.2 Frequency Histograms of Annual Maximum Rainfall Events

B.3.3 RAINFALL INTENSITY-DURATION-FREQUENCY (RIDF) CURVES AT PORT AREA

Using the calculated probable rainfall depths, RIDF curves and equations for different return periods have been constructed as shown in *Figure B.3.3*. After a trail of several types of equations, finally, the form of RIDF equations selected is the Horner type, which fits the data quite well, has been used by other previous studies and has been recommended in ASCE Urban Drainage Manual.

B.3.4 DESIGN RAINFALL HYETOGRAPH

Design rainfall hyetographs with 1-hour time interval have been constructed for different return periods. Construction of design rainfall hyetographs has 2 steps: selection of the shape of hyetographs and computation of incremental rainfall for each time interval of 1-hour. Shape of the design rainfall hyetographs has been generated from mass curve analysis. *Figure B.3.4* shows the mass curves of annual maximum rainfall events for period 1982 to 2003 along with hand fitted average mass curve. The duration of rainfall events are taken as 48 hours for design rainfall hyetographs since the intense part of rainfall amount lies within this time. From the average mass curve, shape of design hyetograph has been generated. Using the equations of RIDF curves, incremental rainfall depths by hour have been computed. Combining the generated rainfall hyetograph shape from mass curve and computed incremental rainfall depth from RIDF equations, design rainfall hyetographs have been constructed for different return periods.

B.3.5 AREAL REDUCTION FACTOR FOR RUNOFF ANALYSIS

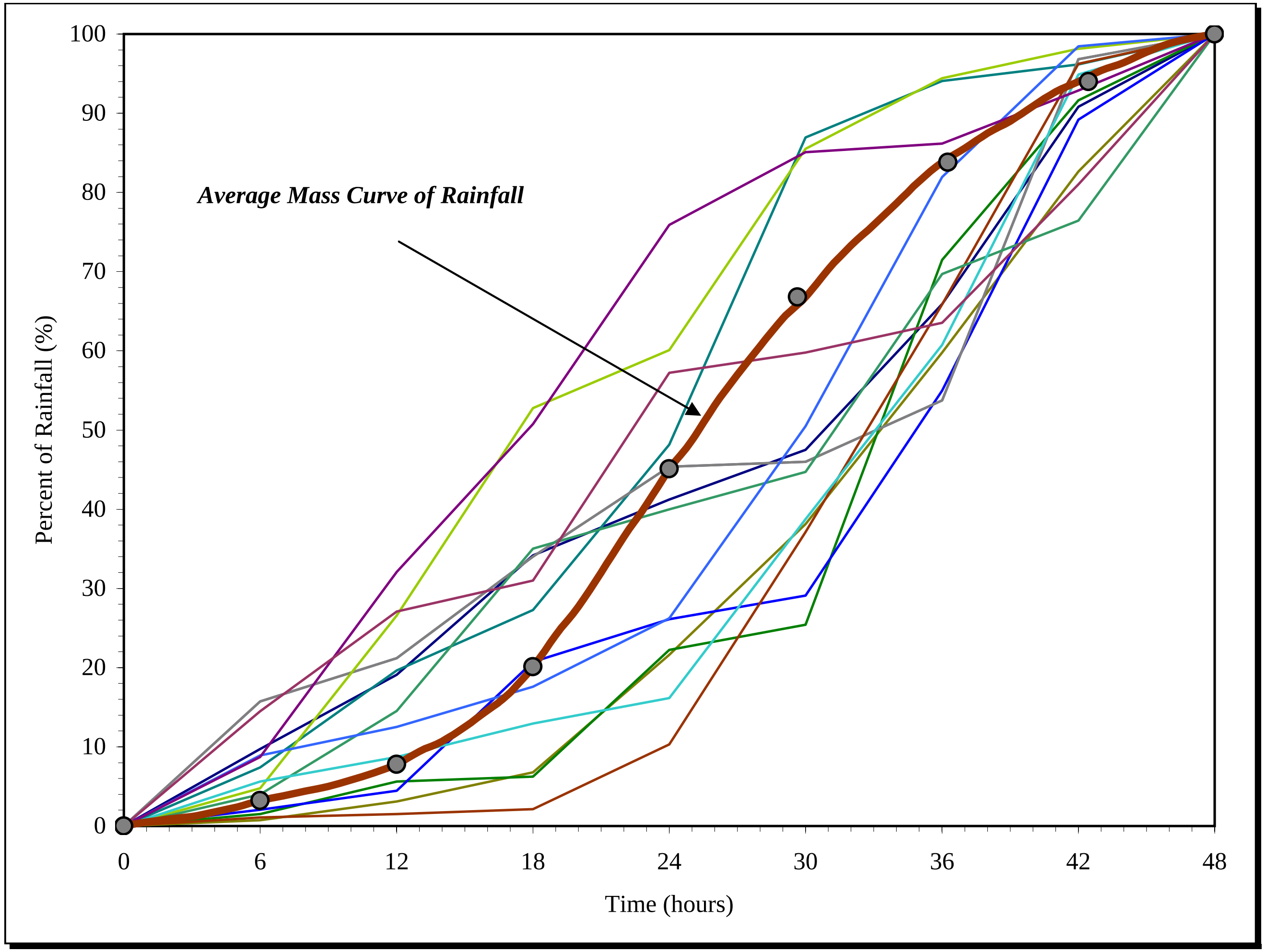
In order to take account of the spatial distribution of rainfall, areal reduction factor (ARF) has been applied to point rainfall data at Port Area. No areal reduction factor curve could be available for Metro Manila. However, World Meteorological Organization (WMO, 1983) has published typical depth-area-duration (DAD) curves as shown in *Figure B.3.5* (top left figure), which have been updated by this Study for the core area using calculated values.

In the updating process, first correlation analyses between point rainfall at Port Area and other stations (Science Garden, NAIA) have been carried out. *Figure B.3.6* shows correlation between Port Area and other stations for rainfall of 6 hours interval during annual extreme rainfall events at Port Area station. Correlation coefficients between Port Area and Science Garden, NAIA and Napindan are found to be 0.77, 0.41 and 0.39, respectively.

Using the results of correlation analyses and Thiessen Polygons, depth-area relation for 6-hour rainfall at core area has been computed and plotted along with WMO DAD curve for 6-hour rainfall, which is shown in *Figure B.3.5*(top right figure). It can be seen that there is some difference between the two values. Therefore, adjustment factors as shown in *Figure B.3.5*(bottom table and bottom right figure) have been applied to WMO DAD curves (same adjustment factor relation for different durations) for calculating areal adjustment factors for different catchments during runoff analysis.

B.3.6 DESIGN TIDE AND WATER LEVELS

Since tide at Manila South Harbor is of mixed type, there is no definite tide pattern that could be applied as design tide. In order to generate design tide for hydrodynamic simulation, tide pattern during annual maximum tide levels in the last five years (1999 to 2003) have been investigated. As shown in *Table B.3.6*, tide patterns during the annual maximum events for the last five years were very similar. Since July ~ August are the most critical months in terms of inundation when both tide level and rainfall are high, the annual maximum tide pattern averaged over the last five years have been selected as the design tide pattern. As for the maximum and minimum design tide levels, mean high spring tide (MHST) level of EL. 11.34 m and mean lower low water (MLLW) level of EL. 10.00 m have been applied. The design tide level is shown in *Table B.3.7*. As for design water levels at the pump stations, same design tide pattern as at Manila Bay with maximum water levels corresponding to 30-year return period (derived from previous studies since 30-year is the design scale of rivers surrounding the study area) and minimum water levels as calculated from the difference between MHST and MLLW at Manila Bay have been used and is presented in *Table B.3.8*.

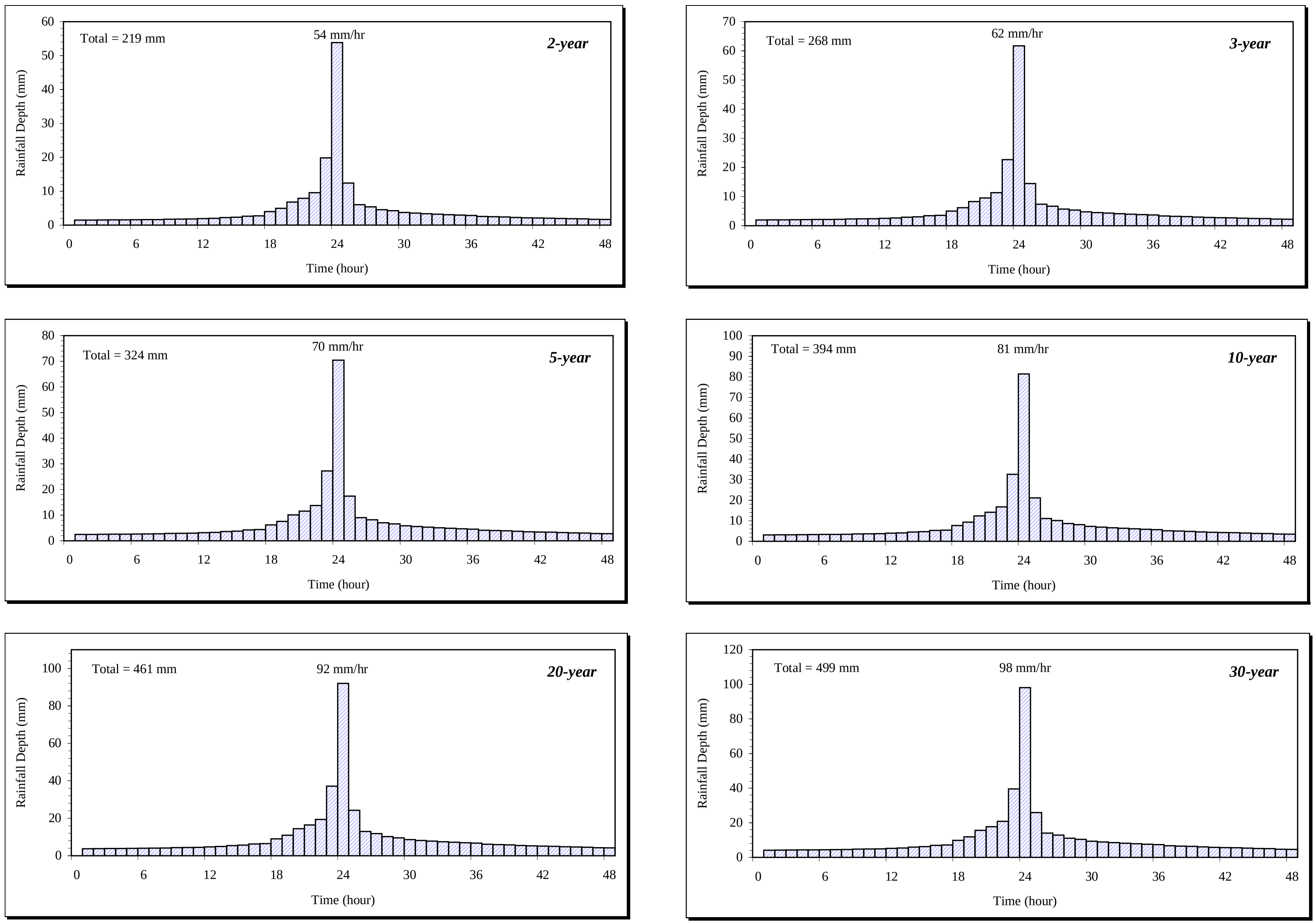


Average Mass Curve of Rainfall at Port Area

Time (hour)	Percent Rain (%)	Time (hour)	Percent Rain (%)
0	***0.0***	***24***	***45.1***
1	0.5	25	48.7
2	0.9	26	53.1
3	1.2	27	57.0
4	1.8	28	60.6
5	2.4	29	64.1
6	***3.2***	***30***	***66.8***
7	3.8	31	70.3
8	4.4	32	73.3
9	5.0	33	75.9
10	5.8	34	78.6
11	6.7	35	81.4
12	***7.8***	***36***	***83.8***
13	9.4	37	85.6
14	10.7	38	87.5
15	12.5	39	89.0
16	14.6	40	90.9
16.9	16.6	41	92.7
18	***20.1***	***42***	***94.0***
19	24.1	43	95.4
20	27.7	44	96.4
21	32.0	45	97.7
22	36.5	46	98.8
23	40.6	47	99.5
24	***45.1***	***48***	***100.0***

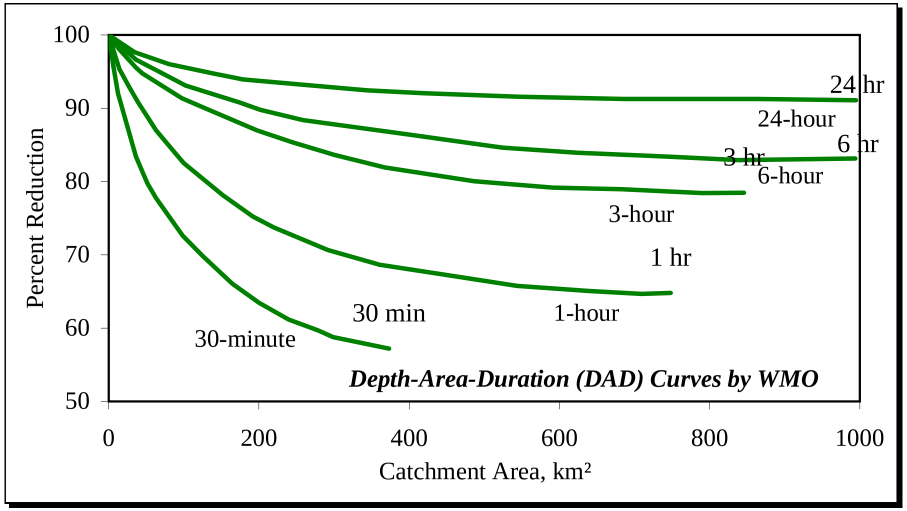
Data : 6-hour rainfall during annual maximum events between period 1982 - 2003

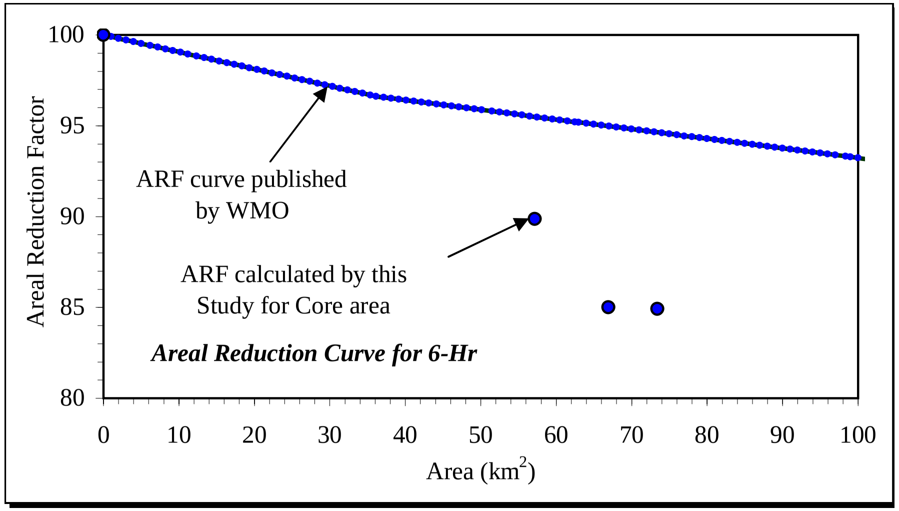
Figure B.3.3 Mass Curve of Rainfall at Port Area Station



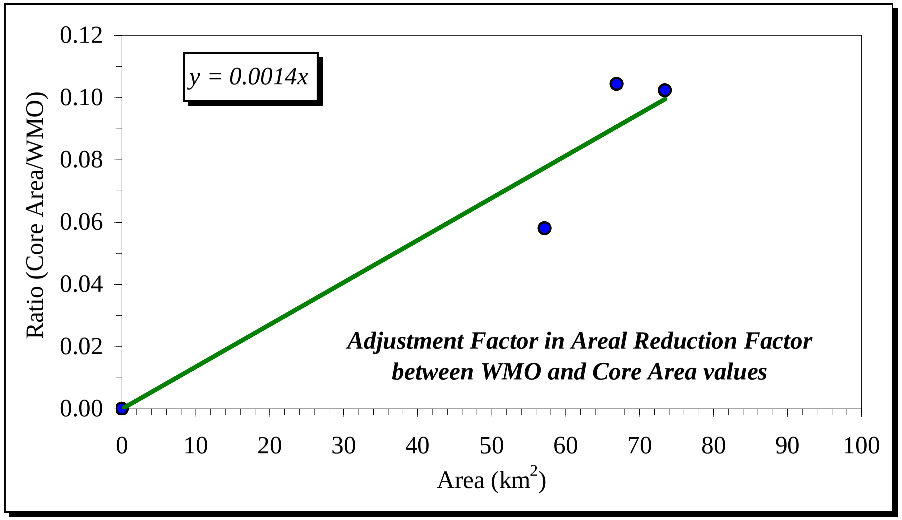
Source: Constructed by this Study based on probable rainfall depths calcuated using data from 1903 ~ 2003

Figure B.3.4 Design Rainfall Hyetographs at Port Area Station



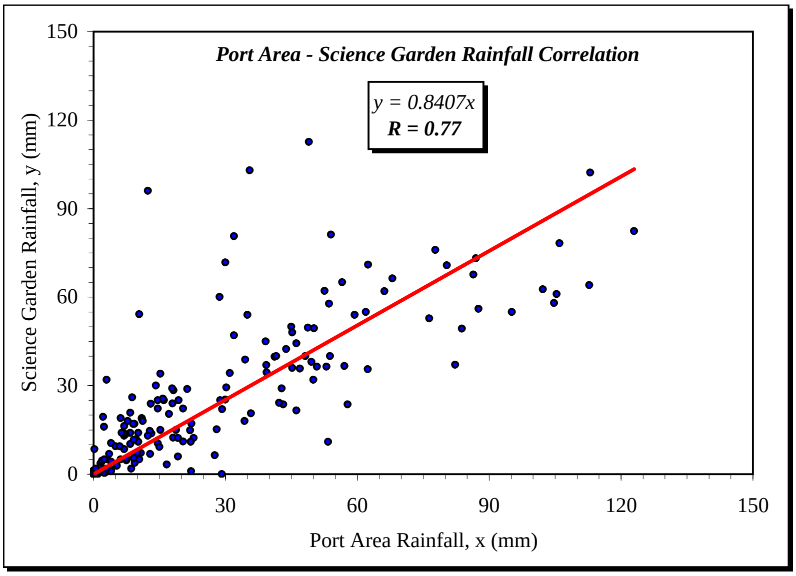


Area (km^2)	ARF: Calculated by this Study for Core Area	ARF: Published Values by WMO	Difference between WMO and Core Area values	Ratio between WMO and Core Area values
0.00	100.0	100.0	0.00	0
57.18	89.9	95.4	5.53	0.06
66.90	85.0	94.9	9.90	0.10
73.42	84.9	94.6	9.68	0.10
			Weighted Average	0.09



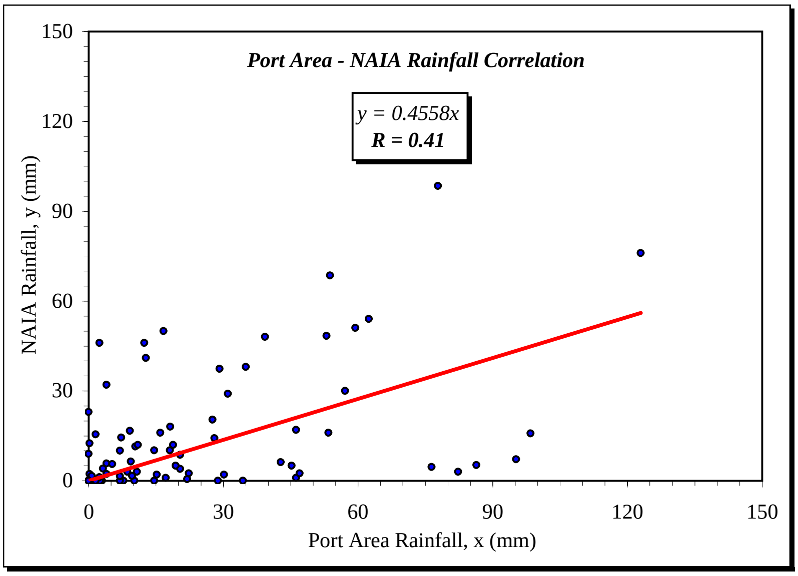
Source: WMO DAD curves from FCSEC which is same as shown in Applied Hydrology by Ven Te Chow, 1988

Figure B.3.5 Areal Reduction Factor for Reducing Point Rainfall to Obtain Areal Average Value in the Study Area



Data :
6-hour total rainfall
during annual maximum
events at Port Area

Period :
Sciecne Garden = 1982 - 2003
NAIA = 1982 - 1992
Napindan = 2002 - 2003



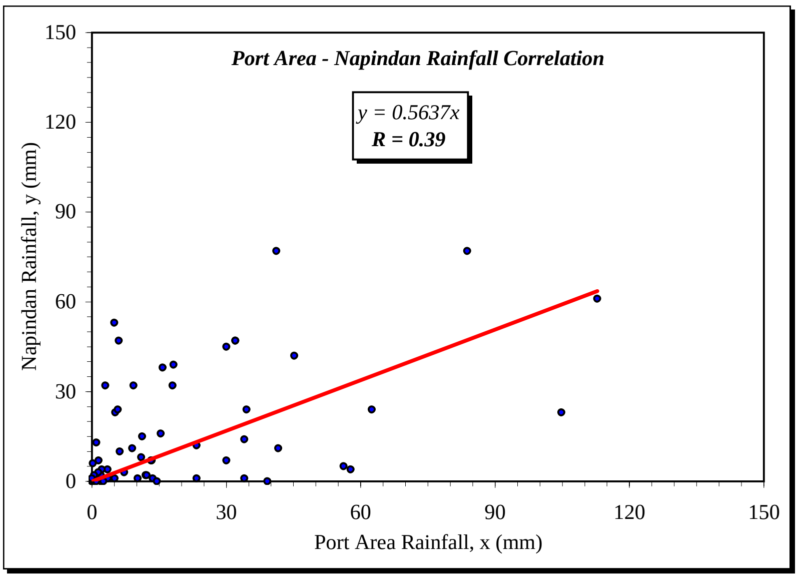


Figure B.3.6 Rainfall Correlations Between Port Area and Other Stations

Table B.3.6 Tide Pattern during Annual Maximum Tide Events (1999 ~ 2003)

1999-July			2000-July			2001-August		
Time mm:dd:yy hh:mm	Difference (hh:mm)	Water Level (EL. m)	Time mm:dd:yy hh:mm	Difference (hh:mm)	Water Level (EL. m)	Time mm:dd:yy hh:mm	Difference (hh:mm)	Water Level (EL. m)
07/12/99 17:06		9.87	07/30/00 17:09		9.86	08/17/01 16:28		9.92
07/13/99 09:26	16:20	11.39	07/31/00 09:26	16:17	11.47	08/18/01 08:33	16:05	11.46
07/13/99 17:52	8:26	9.82	07/31/00 17:52	8:26	9.85	08/18/01 17:09	8:36	9.90
07/14/99 10:17	16:25	11.40	08/01/00 10:22	16:30	11.47	08/19/01 09:32	16:23	11.49
07/14/99 18:36	8:19	9.83	08/01/00 18:34	8:12	9.89	08/19/01 17:47	8:15	9.93
07/15/99 11:07	16:31	11.37	08/02/00 11:20	16:46	11.42	08/20/01 10:34	16:47	11.47
07/15/99 19:19	8:12	9.88	08/02/00 19:14	7:54	9.97	08/20/01 18:25	7:51	10.01
Maximum		11.40	Maximum		11.47	Maximum		11.49

2002-August			2003-July			Average : 1999 ~ 2003	
Time mm:dd:yy hh:mm	Difference (hh:mm)	Water Level (EL. m)	Time mm:dd:yy hh:mm	Difference (hh:mm)	Water Level (EL. m)	Difference (hh:mm)	Water Level (EL. m)
08/07/02 16:57		9.91	07/12/03 16:53		9.82		9.88
08/08/02 08:52	15:55	11.42	07/13/03 08:38	15:45	11.41	16:04	11.43
08/08/02 17:34	8:42	9.89	07/13/03 17:41	9:03	9.75	8:38	9.84
08/09/02 09:46	16:12	11.46	07/14/03 09:29	15:48	11.45	16:15	11.45
08/09/02 18:12	8:26	9.91	07/14/03 18:26	8:57	9.74	8:25	9.86
08/10/02 10:42	16:30	11.46	07/15/03 10:19	15:53	11.44	16:29	11.43
08/10/02 18:49	8:07	9.98	07/15/03 19:08	8:49	9.78	8:10	9.92
Maximum		11.46	Maximum		11.45	Maximum	11.45

Table B.3.7 Design Tide Level at Manila Bay

Design Tide Leveln at Manila Bay		
Difference (hh:mm)	Time dd hh:mm	Tide Level (EL. m)
0:00	Day1 17:00	10.03
16:05	Day2 9:05	11.32
8:40	Day2 17:45	10.00
16:15	Day3 10:00	11.34
8:25	Day3 18:25	10.02
16:30	Day4 10:55	11.32
8:10	Day4 19:05	10.08
Maximum		11.34
Minimum		10.00

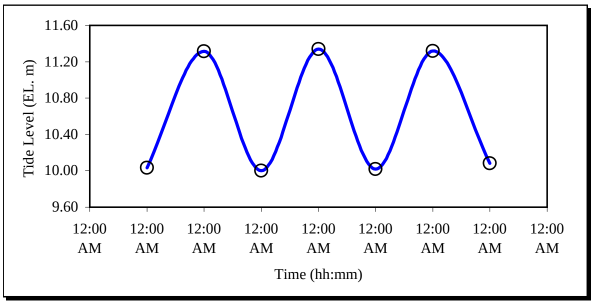


Table B.3.8 Design Water Levels at Pump Stations (30-Year Return Period)

Time	Design Water Level at North Pump Stations (EL. m)				
dd hh:mm	Binondo	Escolta	Quiapo	Aviles	Valencia
Day1 17:00	10.79	10.79	10.88	11.34	11.44
Day2 9:05	12.08	12.08	12.17	12.63	12.73
Day2 17:45	10.76	10.76	10.85	11.31	11.41
Day3 10:00	12.10	12.10	12.19	12.65	12.75
Day3 18:25	10.78	10.78	10.87	11.33	11.43
Day4 10:55	12.08	12.08	12.17	12.63	12.73
Day4 19:05	10.84	10.84	10.93	11.39	11.49
Maximum	12.10	12.10	12.19	12.65	12.75
Minimum	10.76	10.76	10.85	11.31	11.41

Time	Design Water Level at South Pump Stations (EL. m)						
dd hh:mm	Gallina	Balete	Paco	Pandacan	San Andres	Sta. Clara	Makati
Day1 17:00	11.30	11.03	11.10	11.42	12.21	12.36	12.45
Day2 9:05	12.59	12.32	12.39	12.71	13.50	13.65	13.74
Day2 17:45	11.27	11.00	11.07	11.39	12.18	12.33	12.42
Day3 10:00	12.61	12.34	12.41	12.73	13.52	13.67	13.76
Day3 18:25	11.29	11.02	11.09	11.41	12.20	12.35	12.44
Day4 10:55	12.59	12.32	12.39	12.71	13.50	13.65	13.74
Day4 19:05	11.35	11.08	11.15	11.47	12.26	12.41	12.50
Maximum	12.61	12.34	12.41	12.73	13.52	13.67	13.76
Minimum	11.27	11.00	11.07	11.39	12.18	12.33	12.42

C. FLOOD AND INUNDATION

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C.1 GENERAL

The core area of Metropolitan Manila has been suffering from serious flooding and inundation damage resulting from heavy rains brought by southwestern monsoons and typhoons. Metropolitan Manila topographically extends over the low-lying areas along Manila Bay. Rainfall amount and intensity during the rainy seasons especially in the periods of typhoons are heavy and high, respectively. Accordingly, it can be said that the core area is at high risk against natural disasters due to insufficiency of various structural measures and is highly vulnerable to attacks from natural disasters in view of social weakness for coping with disasters. In this chapter, recent inundation condition, flooding and inundation mechanism, etc., are discussed based on the results of site reconnaissance, collected data and analyses of those items.

C.2 AVAILABLE QUANTITATIVE INFORMATION ON INUNDATION IN THE CORE AREA

The core area is inundated at least in some portion almost every year. However, the quantitative information on recent inundations such as depth, duration and areas is quite limited, so is information on damages caused by those. The only available information that has been obtained is as follows.

- Interview survey for inundation in 1999 flood by SEDLMM (2000)[1]
- Flood-prone roads in Metro Manila provided by MMDA[2]
- Interview survey for inundation in August 2004

C.2.1 INTERVIEW SURVEY FOR INUNDATION IN 1999 FLOOD BY SEDLMM (2000)

According to reports, the 1999 flood is the most serious flood in Metro Manila in recent years. In the course of SEDLMM (2000), an interview survey on inundation was conducted, especially in the core area. The items of questionnaire included inundation depth, duration, flow direction and cause of flood. The survey was conducted in 2000, and the total number of respondents was 1,756. The area where the interviews were conducted covered almost the entire low-lying portion in the study area. According to the final report on SEDLMM (2000), the original questionnaire included answer spaces for the floods in both August 1999 and September 1999. However, the results were concluded for the flood in September 1999.

This survey gives us the most detailed quantitative information on recent inundation in the core area. Therefore, it can be used as a reference inundation to evaluate the existing drainage system. The results of the survey and processed data are shown in *Chapter C.3*.

C.2.2 FLOOD-PRONE ROADS IN METRO MANIA PROVIDED BY MMDA

MMDA has statistical data for flood-prone roads in Metro Manila. The data contain the observed maximum depth of floodwater along major roads from 1999 to 2003.

Before 2002, the data had been obtained and managed by NCR, DPWH. At that time, personnel to manage respective roads reported the maximum inundation depth based on their observation. After the flood control section in NCR was transferred to MMDA in 2002, MMDA has continued and strengthened this observation.

Those data tell us the streets that are inundated almost every year. The following streets have had episodes of inundation in three years or more in the last five years.

- España (in front of University of Sto. Tomas) in Sampaloc
- Maceda (corner Calamba St. Vicinity) in Sampaloc
- Rizal Avenue (corner C.M. Recto Avenue) in Sta. Cruz
- C.M. Recto Avenue (Evangelista St. to Rizal Ave.) in Sta. Cruz
- Buendia Canal (Batangas Street) in Makati
- Magallanes Interchange in Makati
- Roxas Boulevard (Buendia Flyover) in Pasay

C.2.3 INTERVIEW SURVEY FOR INUNDATION IN AUGUST 2004

During the course of the present study, severe inundation occurred within the study area in August 2004. It is the first time for the study area to meet such severe inundation since 1999. Considering the importance of gathering the actual condition of the inundation, JICA and the study team decided to conduct interview survey for the inundation. The survey was conducted in October 2004, resulting in total 1,000 respondents within the entire low-lying portion in the study area. The results are shown in *Chapter C.4* together with hydrological information and pump operation records.

C.3 INUNDATION CONDITION IN 1999 FLOOD

C.3.1 RAINFALL AND WATER LEVEL IN MANILA BAY AND THE PASIG RIVER

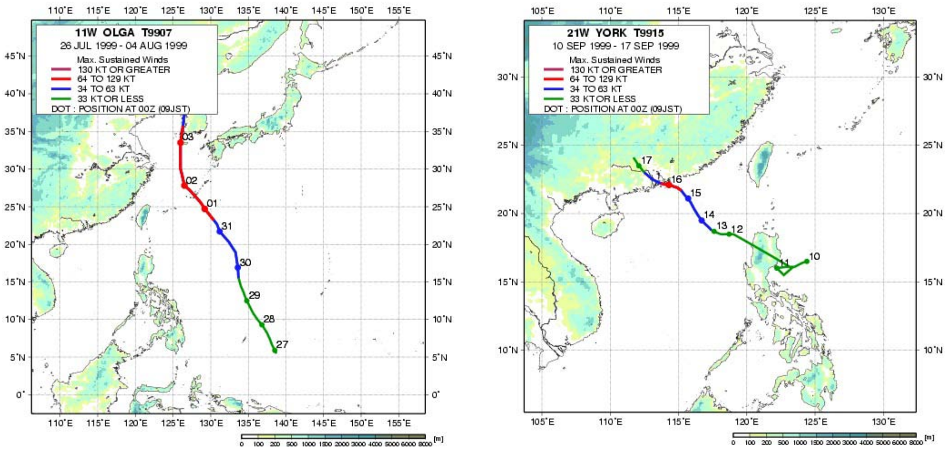
There were three large rainfall events in 1999: August 2-3, September 10-11 and October 16-17. Main causes of those rainfall events are summarized in *Table C.3.1*.

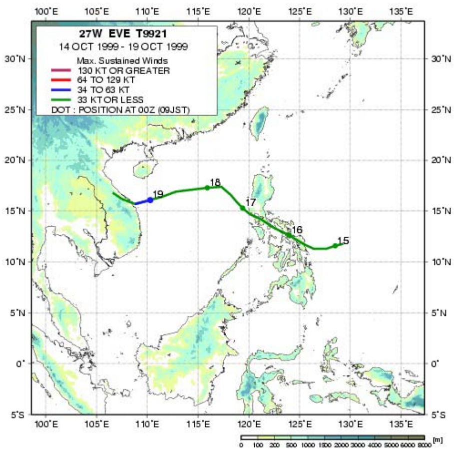
Table C.3.1 Main Causes of Large Rainfall Events in Metro Manila in 1999

Date	*Category*	*Name*	*Maximum 1-min Averaged Wind Speed (m/s)*
August 2-3	*Typhoon*	*OLGA*	*40.8*
September 10-11	*Typhoon*	*YORK*	*35.7*
October 16-17	*Tropical Storm*	*EVE*	*17.9*

Source: Tropical Cyclone Database http://www.eorc.nasda.go.jp/TRMM/typhoon/index_e.htm

Figure C.3.1 demonstrates the tracks of these typhoons or tropical storm. Typhoon OLGA in August was very large, although it did not hit Metro Manila directly. It is inferred that typhoon-associated clouds brought about heavy rain in August. On the other hand, there were typhoons smaller than typhoon OLGA, but they attacked Metro Manila directly. The heavy rainfall and wind was directly brought by the typhoon.



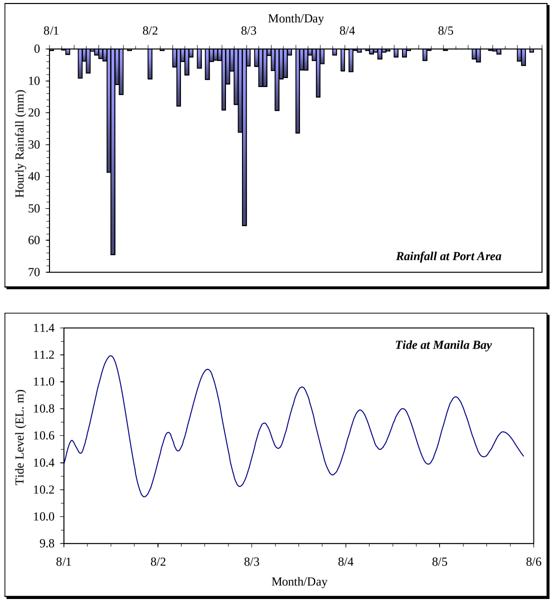


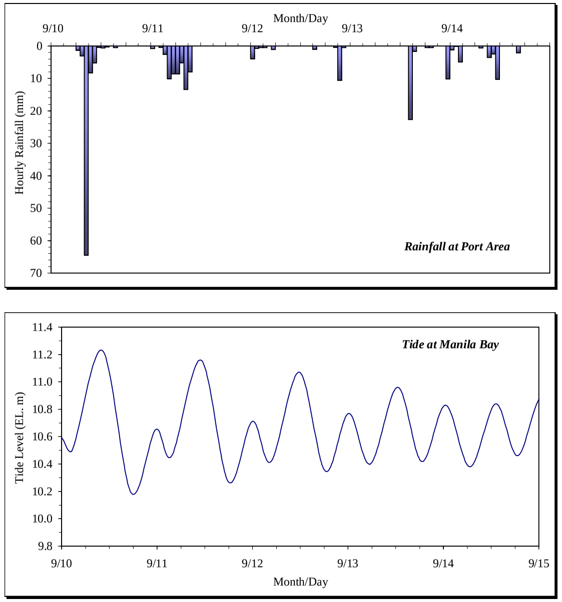
Source: Tropical Cyclone Database
http://www.eorc.nasda.go.jp/
TRMM/typhoon/index_e.htm

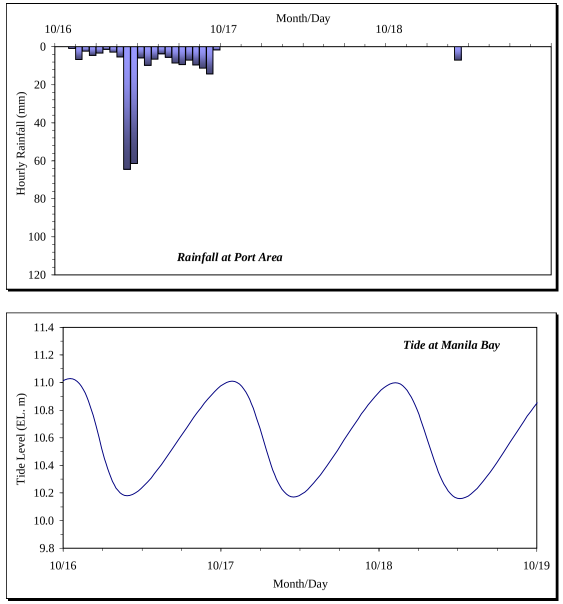
Figure C.3.1　Tracks of Typhoons or Tropical Storm during 1999 Inundation

The meteo-hydrological condition of 1999 inundation has been investigated and is presented in *Figure C.3.2*.　The rainfall was analyzed using the chart data provided by PAGASA.　Among the three rainfall events, the largest rainfall event was in August 1999.　Evaluation on return period of the three rainfall events is presented in *Table C.3.2*.　At Port Area, maximum 24-hour rainfall depths were 278 mm, 116 mm and 247 mm in August September and October 1999, which correspond to 12-year, <2-year and 8-year return periods, respectively.　Regarding short time rainfall, almost the same amount of 1-hour rainfall (65 mm/hour) in these events was observed, which corresponds to a 4-year return period.

Rainfall in September 1999 was actually quite small according to the observed rainfall data in Port Area station.　There seems to be a contradiction to conclude that the result of interview survey in SEDLMM reflects only September inundation, because the rainfall data support that the inundations in August and October were also severe.　Normally, people’s memory on timing of the events is not so reliable, especially, when many events with similar magnitude occurred.　It is quite natural to assume that the result of interview reflects all of the events.







Source: Hourly rainfall data at Port Area is from chart obtained from Flood Forecasting and Warning Center of PAGASA and tide data at Manila South Harbor is from NAMRIA

August 1999 Rain and Tide *September 1999 Rain and Tide* *October 1999 Rain and Tide*

Figure C.3.2 Meteo-Hydrological Condition during 1999 Inundation

Table C.3.2 Evaluation of Return Period of 1999 Inundation

August 1999 Rain

Station	Rainfall	Duration				
		1-hr	6-hr	12-hr	24-hr	48-hr
Port Area	Amount (mm)	64	136	174	278	455
	Return Period (Year)	4	4	4	12	19

September 1999 Rain

Station	Rainfall	Duration				
		1-hr	6-hr	12-hr	24-hr	48-hr
Port Area	Amount (mm)	65	83	84	116	148
	Return Period (Year)	4	2	< 2	< 2	< 2

October 1999 Rain

Station	Rainfall	Duration				
		1-hr	6-hr	12-hr	24-hr	48-hr
Port Area	Amount (mm)	64	153	203	247	247
	Return Period (Year)	4	5	7	8	3

Since August 1999 had the highest rainfall amount, therefore, the hydrodynamic model developed during this study applied the August 1999 rainfall for model calibration. From results of probability analyses and also from inundation analyses using hydrodynamic simulation for different design rainfall events, it is concluded that the magnitude of August 1999 inundation is from 5-year to 10-year return period. The detail of hydrodynamic model is described in *Supporting Report D.*

Tide level at Manila South Harbor was high during these periods. The observed maximum water levels at pumping stations along the Pasig River during August 2-3, September 10-11 and October 16-17 are shown in *Table C.3.3.* Among these, most severe condition, which has the highest water level, appeared in August.

Table C.3.3 Observed Maximum Water Level along the Pasig River during 1999 Inundation

Pumping Station	*Binondo*	*Escolta*	*Quiapo*	*Balete*	*Paco*	*Aviles*	*Pandacan*
Chanage (km)	*1+550*	*2+150*	*2+600*	*3+300*	*3+650*	*4+800*	*5+200*
DHWL (m)	*12.10*	*12.10*	*12.19*	*12.34*	*12.41*	*12.65*	*12.73*
OMWL (m) August 1999	*N/A*	*11.85*	*N/A*	*12.2*	*12.2*	*12.4*	*12.5*
OMWL (m) September 1999	*N/A*	*11.7*	*N/A*	*11.9*	*11.8*	*11.9*	*12.1*
OMWL (m) October 1999	*N/A*	*11.8*	*N/A*	*12.05*	*12.0*	*12.1*	*12.25*

Pumping Station	*Valencia*	*San Andres*	*Sta. Clara*	*Makati*
Chanage (km)	*5+300*	*8+350*	*10+850*	*12+350*
DHWL (m)	*12.75*	*13.52*	*13.67*	*13.76*
OMWL (m) August 1999	*12.65*	*N/A*	*13.5*	*13.55*
OMWL (m) September 1999	*12.0*	*12.7*	*12.7*	*12.7*
OMWL (m) October 1999	*12.2*	*N/A*	*12.5*	*12.8*

Note:
DHWL = Design High Water Level in the Pasig River
OMWL= Observed Maximum Water Level in the Pasig River

Elevation is above DPWH Datum.

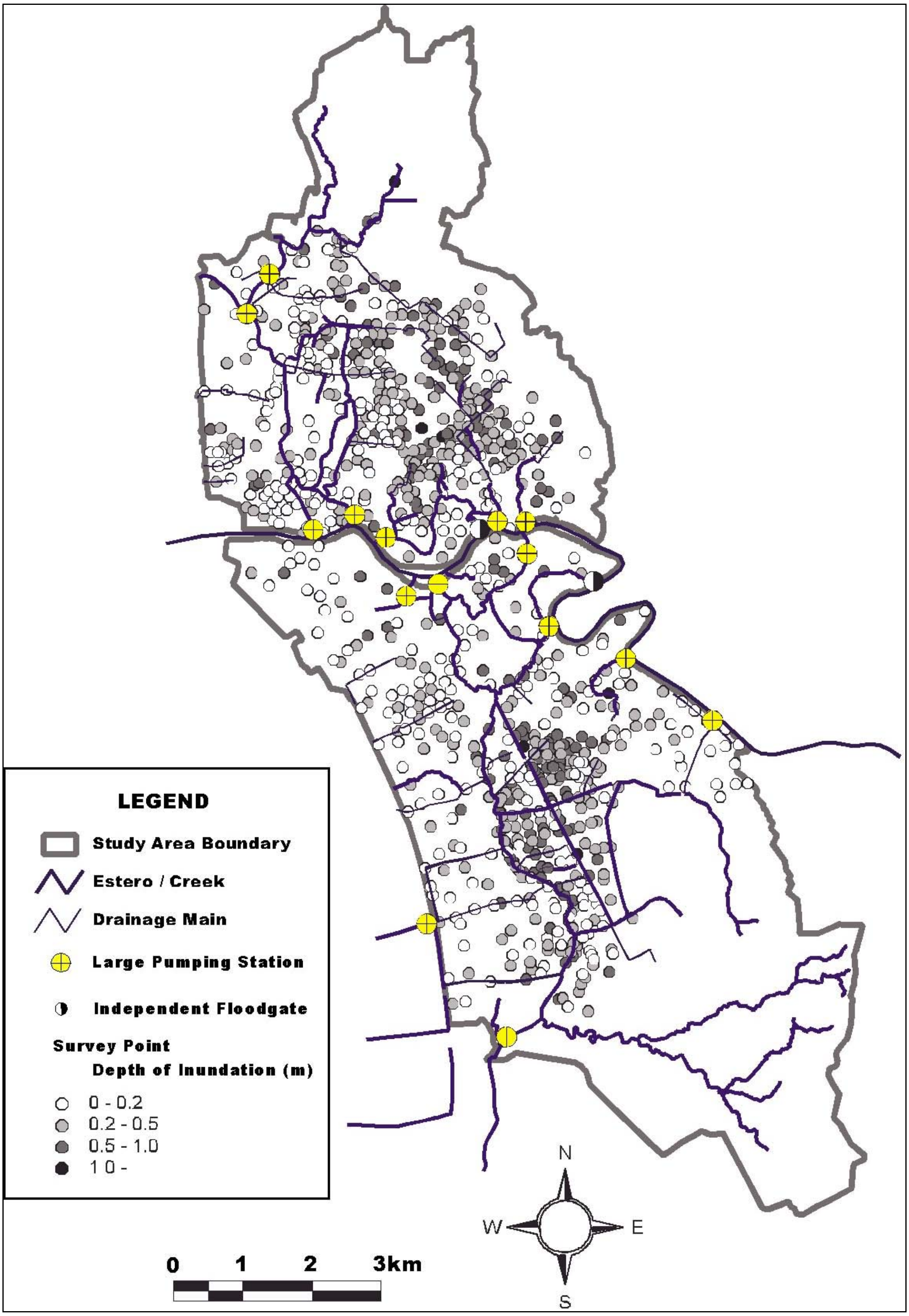
Source DHWH: DPWH, Project for Pasig-Marikina River Flood Control, 2002.[3]
OMWL: Pump operation records provided by MMDA

C.3.2 INUNDATION MAPPING

After removing duplicated points in the database on the inundation survey by SEDLMM, a total of 838 survey points have been utilized to get an inundation map in 1999 flood. The survey points are shown in *Figure C.3.3* with maximum depth of inundation. Based on those point data, contour maps for inundation depth and duration have been arranged using GIS. Singular points to make the contour strange were removed during several trials, and reasonable contours have been finally obtained. Estimated total area that has more than 20 cm maximum inundation depth is about 29.5 km^2 (about 40% of the study area).

Figures C.3.4 and *C.3.5* show the contour maps of maximum inundation depth and duration, respectively. The maximum inundation depth is around 1.3 m, which appears along España Street in North Manila and along PNR Canal in South Manila. The area in which depth of inundation is deeper than 0.5 m extends widely in the central part of North Manila. Duration of inundation in this area exceeds 24 hours. In South Manila, deep inundation occurs along the eastside of PNR Canal and along Estero de Tripa de Gallina. Duration of inundation is less than 12 hours in those areas, however.

In North Manila, the ground elevation near University of Sto.Tomas along España Street is lower than other portions, which makes the inundation depth deeper in this area. The excess floodwater from surrounding area seems to concentrate into this lower area. In South Manila, along Zobel-Roxas drainage main does the maximum depth of inundation does vary. There are two peaks along the Zobel-Roxas drainage main. The shallower portion between the two peaks appears at the west of PNR Canal, which runs next to South Super Highway. This fact indicates that South Super Highway and/or its surrounding area would act as a barrier to prevent the draining of the water accumulated in the east of it.



Data source: SEDLMM database (2000)

Figure C.3.3 Survey Points for Interview Survey on 1999 Inundation

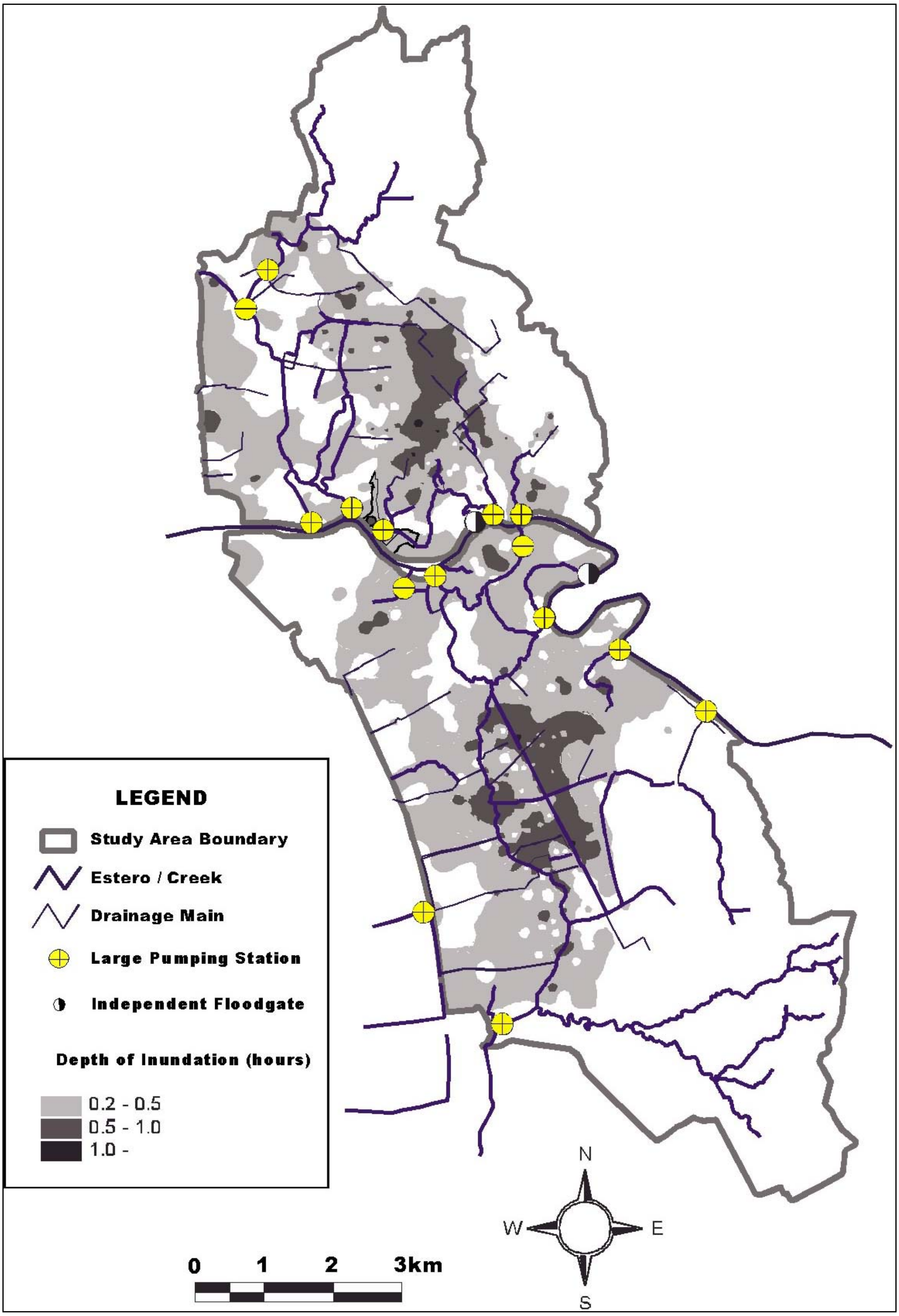


Figure C.3.4 Maximum Depth in 1999 Inundation

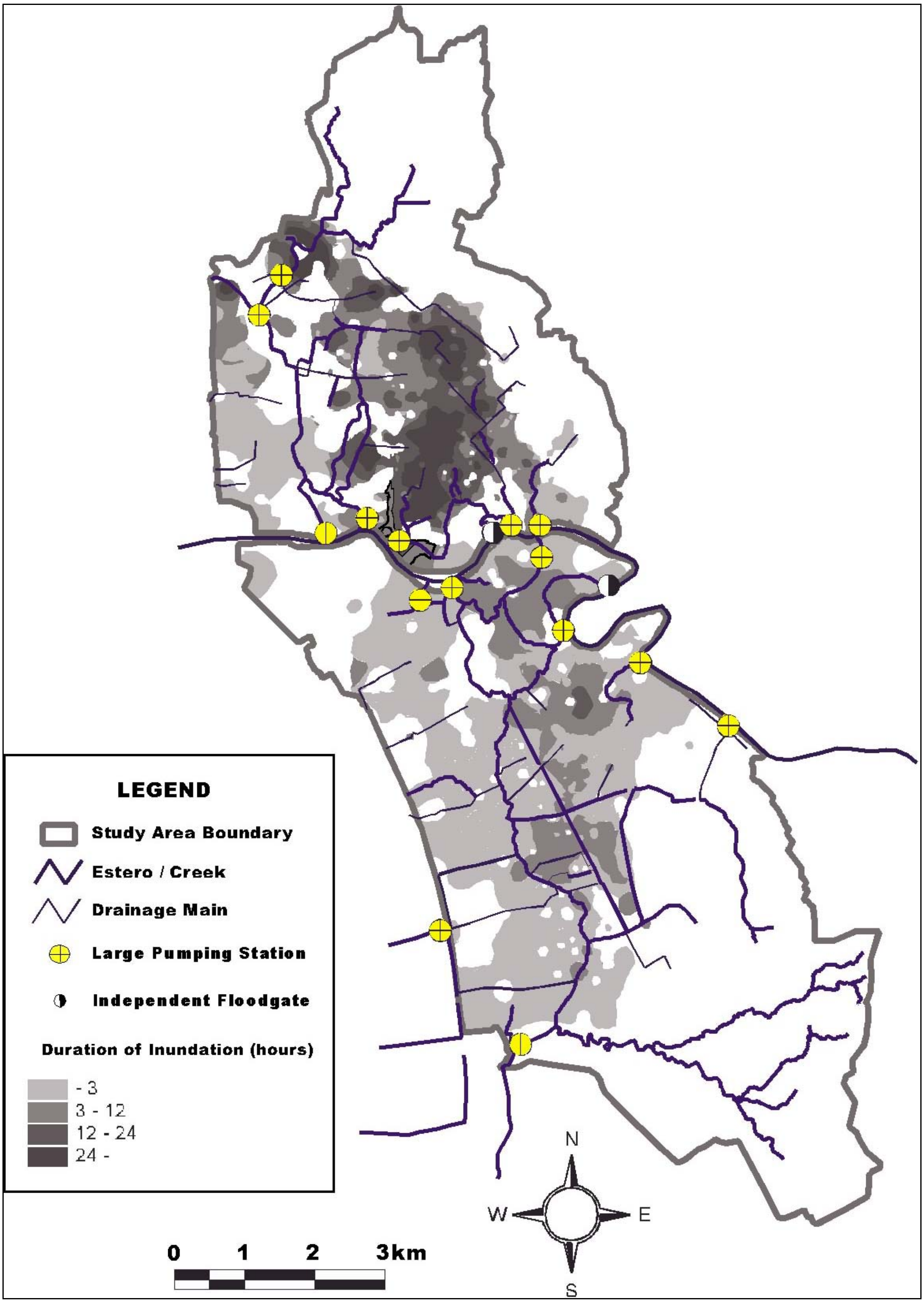


Figure C.3.5 Duration in 1999 Inundation

C.3.3 INUNDATION CONDITIONS WITH BASINS

Table C.3.4 summarizes the average maximum depth of inundation and the average duration of inundation for each drainage basin

Table C.3.4 Inundation Conditions with Basins

Block_ID	*Basin_ID*	*Name*	*Drainage Area (km^2)*	*Average Depth of Inundation (m)*	*Average Duration of Inundation (hour)*
N01	*N01_01*	*Vitas*	*5.27*	*0.27*	*10.3*
	N01_02	*Binondo*	*2.69*	*0.20*	*8.4*
	N01_03	*Escolta*	*0.30*	*0.00*	*0.0*
N02	*N02_01*	*Quiapo*	*2.29*	*0.39*	*18.4*
	N02_02	*Aviles*	*3.28*	*0.22*	*7.4*
N03	*N03_01*	*Valencia*	*2.37*	*0.06*	*0.7*
N04	*N04_01*	*Maypajo-Blumentritt*	*9.42*	*0.02*	*0.7*
	N04_02	*Balut*	*0.49*	*0.17*	*8.0*
N05	*N05_01*	*North Harbor*	*2.37*	*0.25*	*3.3*
S01	*S01_01*	*Tripa de Gallina*	*17.05*	*0.04*	*0.3*
	S01_02	*Libertad*	*7.48*	*0.37*	*2.3*
	S01_03	*Vito Cruz*	*1.43*	*0.12*	*0.5*
S02	*S02_01*	*Balete*	*0.94*	*0.30*	*1.2*
S03	*S03_01*	*Paco*	*1.74*	*0.24*	*2.4*
	S03_02	*Pandacan*	*1.15*	*0.32*	*3.3*
	S03_03	*San Andres*	*3.23*	*0.33*	*3.3*
S04	*S04_01*	*Sta. Clara*	*1.57*	*0.29*	*2.4*
S05	*S05_01*	*Makati*	*1.65*	*0.00*	*0.0*
	S05_02	*Upper Calatagan*	*2.66*	*0.00*	*0.0*
S06	*S06_01*	*South Harbor*	*3.66*	*0.10*	*0.7*
	S06_02	*Pasig South*	*1.03*	*0.12*	*0.2*
	S06_03	*Paranaque*	*0.20*	*0.03*	*0.2*

C.3.4 ESTIMATED DAMAGES

There is no available quantitative information on damages caused by inundation in 1999, unfortunately. The only available method to estimate the damages is to utilize currently developed GIS database in Metro Manila[4] with the inundation map based upon the interview survey. Using overlay technique of GIS, the following are estimated.

- Number of affected people: *Table C.3.5*
- Number of affected houses/buildings: *Table C.3.6*
- Total length of inundated road: *Table C.3.7*

Table C.3.5 Estimated Number of Affected People

(1) Affected Population with Maximum Depth of Inundation

	Maximum Depth of Inundation (m)			*Total*
	0.2 – 0.5	*0.5 – 1.0*	*1.0 – 1.3*	
North Manila	*562,810*	*78,220*	*110*	*641,140 (50%)*
South Manila	*498,440*	*100,130*	*950*	*599,520 (63%)*
Total	*1,061,250 (47%)*	*178,350 (8%)*	*1,060 (<1%)*	*1,240,660 (55%)*

(2) Affected Population with Duration of Inundation (Maximum Depth of Inundation is more than 0.2 m)

	Duration of Inundation (hour)						*Total*
	0 -1	*1 – 3*	*3 - 6*	*6 – 12*	*12 – 24*	*24 -*	
North Manila	*12,170*	*215,480*	*107,630*	*105,030*	*134,160*	*66,670*	*641,140 (50%)*
South Manila	*21,790*	*398,550*	*120,770*	*45,290*	*12,120*	*0*	*599,520 (63%)*
Total	*33,960 (1%)*	*614,030 (27%)*	*228,400 (10%)*	*150,320 (7%)*	*147,280 (7%)*	*66,670 (3%)*	*1,240,660 (55%)*

Note:
Total population in North Manila = 1,305,947
Total population in South Manila = 945,910
Total population in the study area = 2,251,857

Table C.3.6 Estimated Number of Affected Houses/Buildings

(1) Affected Houses/Buildings with Maximum Depth of Inundation

	Maximum Depth of Inundation (m)			*Total*
	0.2 – 0.5	*0.5 – 1.0*	*1.0 – 1.3*	
North Manila	*42,840*	*7,790*	*10*	*50,640 (45%)*
South Manila	*38,280*	*8.970*	*90*	*47,340 (58%)*
Total	*81,120 (41%)*	*16,760 (9%)*	*100 (<1%)*	*97,980 (50%)*

(2) Affected Houses/Buildings with Duration of Inundation
(Maximum Depth of Inundation is more than 0.2 m)

	Duration of Inundation (hour)						*Total*
	0 –1	*1 – 3*	*3 - 6*	*6 – 12*	*12 - 24*	*24 -*	
North Manila	*900*	*17,430*	*7,400*	*8,220*	*10,810*	*5,880*	*50,640 (45%)*
South Manila	*1,780*	*31,600*	*9,610*	*3,650*	*700*	*0*	*47,340 (58%)*
Total	*2,680 (1%)*	*49,030 (25%)*	*17,010 (9%)*	*11,870 (6%)*	*11,510 (6%)*	*5,880 (3%)*	*97,980 (50%)*

Note:
Total number of houses/buildings in North Manila = 113,494
Total number of houses/buildings in South Manila = 82,168
Total number of houses/buildings in the study area = 195,662

Table C.3.7 Estimated Total Length of Inundated Road

(1) Total length of Inundated Road with Maximum Depth of Inundation in North Manila (Unit:km)

	Maximum Depth of Inundation (m)			*Total*
	0.2 – 0.5	*0.5 – 1.0*	*1.0 – 1.3*	
Major Arterial	*14.7*	*3.0*	*0.1*	*17.8 (48%)*
Minor Arterial	*10.7*	*4.3*	*0*	*15.0 (42%)*
Others	*192.7*	*39.7*	*0.5*	*232.9 (42%)*
Total	*218.1 (35%)*	*47.0 (7%)*	*0.6 (<1%)*	*265.7 (42%)*

(2) Total length of Inundated Road with Duration of Inundation in North Manila (Unit:km)
(Maximum Depth of Inundation is more than 0.2 m)

	Duration of Inundation (hour)						*Total*
	0 -1	*1 – 3*	*3 - 6*	*6 – 12*	*12 - 24*	*24 -*	
Major Arterial	*0.3*	*4.6*	*3.1*	*2.8*	*4.0*	*3.0*	*17.8 (45%)*
Minor Arterial	*0.2*	*4.8*	*1.0*	*2.0*	*5.0*	*2.1*	*15.0 (58%)*
Others	*3.9*	*65.5*	*32.9*	*41.8*	*52.8*	*36.0*	*232.9 (42%)*
Total	*4.4 (<1%)*	*74.9 (13%)*	*37.0 (6%)*	*46.6 (7%)*	*52.8 (8%)*	*41.1 (7%)*	*265.7 (42%)*

Note:
Total length of major arterial in North Manila = 37.5 km
Total length of minor arterial in North Manila = 36.1 km
Total length of other raods in North Manila = 555.8 km
Total length of roads in North Manila = 629.4 km

(3) Total length of Inundated Road with Maximum Depth of Inundation in South Manila (Unit:km)

	Maximum Depth of Inundation (m)			*Total*
	0.2 – 0.5	*0.5 – 1.0*	*1.0 – 1.3*	
Major Arterial	*22.0*	*2.8*	*<0.1*	*24.8 (48%)*
Minor Arterial	*22.7*	*3.5*	*0.1*	*26.3 (42%)*
Others	*233.9*	*59.1*	*0.6*	*293.6 (45%)*
Total	*278.6 (37%)*	*65.4 (8%)*	*0.7 (<1%)*	*344.7 (45%)*

(4) Total length of Inundated Road with Duration of Inundation in South Manila (Unit:km)
(Maximum Depth of Inundation is more than 0.2 m)

	Duration of Inundation (hour)						*Total*
	0 -1	*1 – 3*	*3 - 6*	*6 – 12*	*12 - 24*	*24 -*	
Major Arterial	*1.8*	*18.6*	*3.3*	*1.1*	*0*	*0*	*24.8 (48%)*
Minor Arterial	*2.3*	*17.0*	*5.1*	*1.7*	*0.2*	*0*	*26.3 (42%)*
Others	*16.6*	*197.2*	*57.2*	*19.4*	*3.2*	*0*	*293.6 (45%)*
Total	*20.7 (3%)*	*232.8 (30%)*	*65.6 (9%)*	*22.3 (3%)*	*3.3 (<1%)*	*0 (0%)*	*344.7 (45%)*

Note:
Total length of major arterial in South Manila = 51.5 km
Total length of minor arterial in South Manila = 61.5 km
Total length of other raods in South Manila = 647.8 km
Total length of roads in South Manila = 760.9 km

C.3.5 MAJOR PROBLEM AREAS

Because of implementation of flood control and drainage improvement made so far, flood and inundation situation has been so much improved in Metropolitan Manila. However, it still remains at several areas and particular local spots. Problem areas can be categorized into two aspects of regional and local inundation areas, based on available information in 1999 inundation. Regional inundation area is the widely spreading portion whose depth of inundation is more than 0.5m, whereas local inundation area is the area where inundation is limited locally.

(1) Regional and Local Inundation Areas in North Manila

The regional inundation area in north Manila is Aviles Sampaloc area in the upper catchments of Quiapo-Aviles, Vitas-Binondo-Escolta and Maypajo-Blumentritt-Balut drainage blocks. The regional inundation is caused not only by local storm water in Quiapo-Aviles and Vitas-Binondo-Escolta drainage blocks but also by excess storm water in the hilly area of Maypajo-Blumentritt-Balut drainage block. Trunk road España Street running through the regional inundation area is suffering from severe traffic interruptions almost every year. Other drainage blocks do not have so serious and regional problems. However, local inundation areas remain at several spots.

(2) Regional and Local Inundation Areas in South Manila

The regional inundation area in South Manila is San Isidro, San Antonio and Pio del Pilar area covered by drainage channels of Zobel-Roxas, PNR Canal and Calatagan Creek I in Libertad-Tripa de Gallina drainage block. Due to various structural and social problems, this area is frequently inundated, even in the dry season from November to April. A trunk road, South Super Highway, running along PNR is suffering from frequent inundations, resulting in severe traffic interruption. In other drainage blocks, serious regional inundation cannot be observed. Local inundation areas are observed at several spots along Estero de Tripa de Gallina, in Balete drainage block, near Pandacan pumping station, etc., however.

C.4 INUNDATION CONDITION IN AUGUST 2004

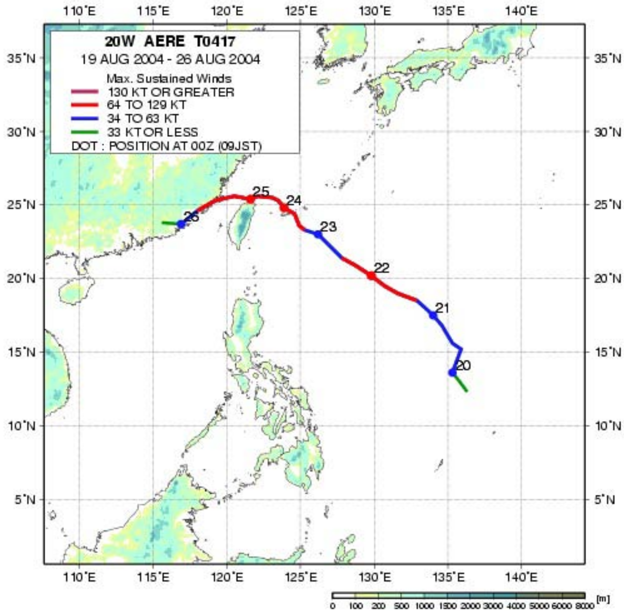
C.4.1 RAINFALL AND WATER LEVEL IN MANILA BAY AND THE PASIG RIVER

In early morning in 25 August 2004, heavy rainfall events occurred in the study area. Typhoon AERE caused this rainfall event. *Table C.4.1* summarizes the nature of Typhoon AERE. *Figure C.4.1* shows the track of the typhoon. The typhoon did not directly hit the Metro Manila. When the center of the typhoon reached Taiwan, the heavy rainfall occurred in the Metro Manila. It is interesting that similar weather pattern was observed in August 1999.

Table C.4.1 Nature of Typhoon AERE in August 2004

Date	*Category*	*Name*	*Maximum 1-min Averaged Wind Speed (m/s)*
August 25-26	*Typhoon*	*AERE*	*43.4*

Source: Tropical Cyclone Database http://www.eorc.nasda.go.jp/TRMM/typhoon/index_e.htm



Source: Tropical Cyclone Database
http://www.eorc.nasda.go.jp/TRMM/typhoon/index_e.htm

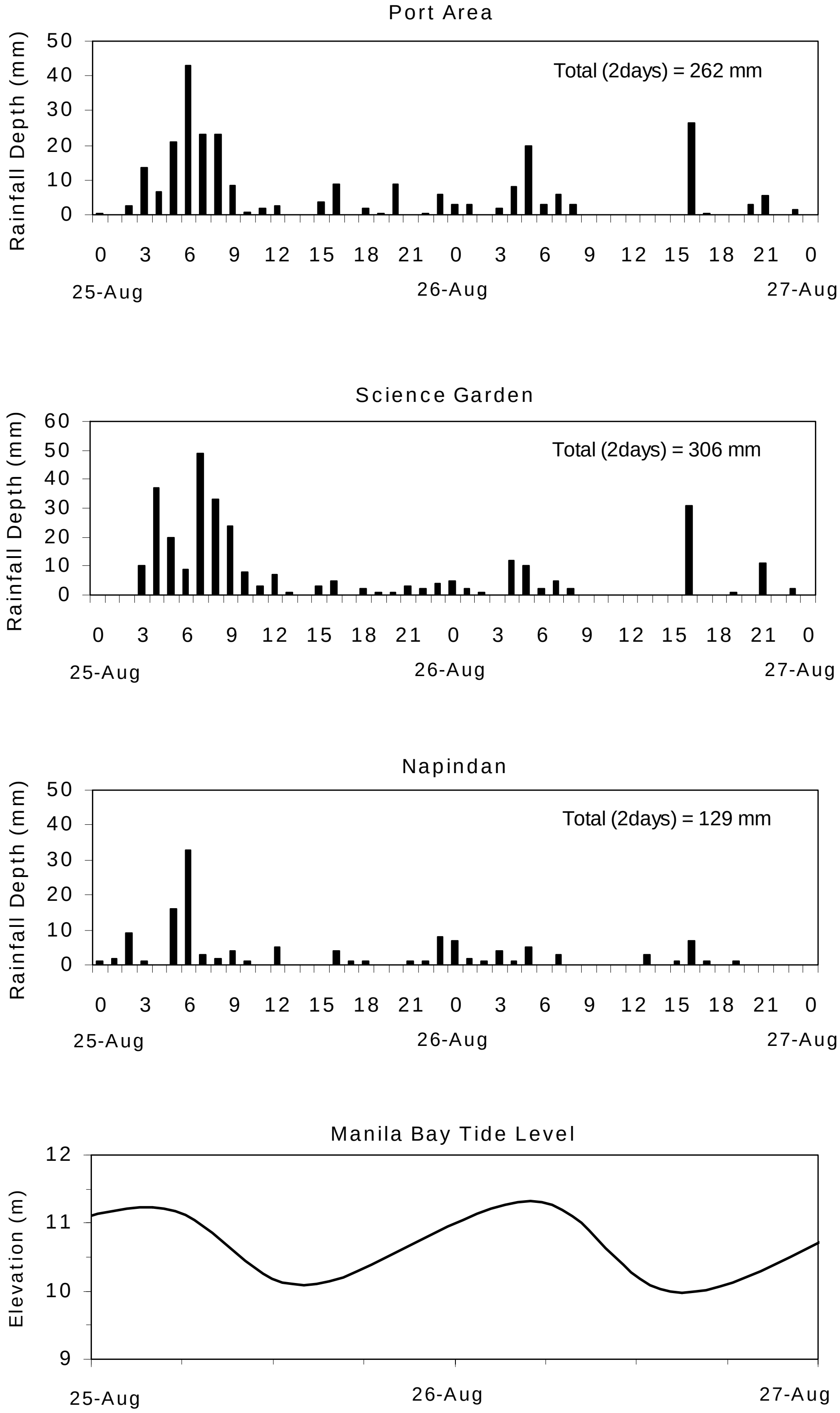
Figure C.4.1 Tracks of Typhoon AERE in August 2004

The rainfall amount and pattern during the heavy rainfall event has been investigated by analyzing the chart data provided by PAGASA for Port Area Stations. Aside from this, the rainfall records in Science Garden and Napindan were provided by EFCOS and the tide level at Manila Bay was obtained by Tide Table 2004 issued by NAMRIA. *Figure C.4.2* shows the rainfall patterns in those three stations and the tide level at Manila Bay. It can be seen that the single peak appeared early morning in 25 August. At that time, the tide level was also almost peak.

Table C.4.2 shows continuous rainfall amount for several durations in three stations. At Port Area, maximum 24-hour rainfall depth was 183 mm, which corresponds to 3-year return periods. Maximum 6-hour to 12-hour rainfall depths are also equivalent to almost 3-year return period. However, return period of maximum rainfall depth with shorter duration is less than 2-years.

At Science Garden, the total 2-days rainfall amount (306 mm) is higher than that at Port Area (262 mm). Maximum 24-hour rainfall depth was 230 mm, which corresponds to 5-year return periods. Maximum 6-hour to 12-hour rainfall depths are equivalent to 5-year return period or more. Return period of maximum rainfall depth with shorter duration is less than 2-years.

Rainfall amount and intensity at Napindan is much smaller than those at the other stations. The maximum 24-hours rainfall depth at Napindan is only 99 mm. This fact shows that the south of the study area received much smaller rainfall compared to the north.



Source:
Port Area: Chart data by PAGASA, Science Garaden and Napindan: EFCOS
Tide level: NAMRIA

Figure C.4.2 Meteo-Hydrological Condition during August 2004 Inundation

Table C.4.2 Evaluation of Return Period of August 2004 Inundation

Port Area

	60min	2hours	3hours	6hours	12hours	24hours	48hours
Maximum	**44.0**	**81.5**	**97.0**	**136.7**	**147.4**	**183.1**	**262.0**
Return Period	**<2**	**2 - 3**	**-**	**3 - 5**	**2 - 3**	**3**	**3**

Science Garden

	60min	2hours	3hours	6hours	12hours	24hours	48hours
Maximum	**49.0**	**82.0**	**106.0**	**172.0**	**201.0**	**230.0**	**306.0**
Return Period	**<2**	**2 - 3**	**-**	**5- 10**	**5-10**	**5**	**3 - 5**

Napindan

	60min	2hours	3hours	6hours	12hours	24hours	48hours
Maximum	**33.0**	**49.0**	**52.0**	**62.0**	**76.0**	**99.0**	**129.0**
Return Period	**-**	**-**	**-**	**-**	**-**	**-**	**-**

The observed maximum water levels at pumping stations along the Pasig River are shown in *Table C.4.3*. The maximum water levels along the Pasig River were lower than those during August 1999 inundation.

Table C.4.3 Observed Maximum Water Level along the Pasig River During August 2004 Inundation

Pumping Station	*Binondo*	*Escolta*	*Quiapo*	*Balete*	*Paco*	*Aviles*	*Pandacan*
Chanage (km)	*1+550*	*2+150*	*2+600*	*3+300*	*3+650*	*4+800*	*5+200*
DHWL (m)	*12.10*	*12.10*	*12.19*	*12.34*	*12.41*	*12.65*	*12.73*
OMWL (m) August 1999	*N/A*	*11.85*	*N/A*	*12.2*	*12.2*	*12.4*	*12.5*
OMWL (m) August2004	*11.75*	*11.8*	*11.75*	*11.95*	*12.0*	*12.05*	*12.0*

Pumping Station	*Valencia*	*San Andres*	*Sta. Clara*	*Makati*
Chanage (km)	*5+300*	*8+350*	*10+850*	*12+350*
DHWL (m)	*12.75*	*13.52*	*13.67*	*13.76*
OMWL (m) August 1999	*12.65*	*N/A*	*13.5*	*13.55*
OMWL (m) August 2004	*12.05*	*12.4*	*12.5*	*12.7*

Note:
DHWL = Design High Water Level in the Pasig River
OMWL= Observed Maximum Water Level in the Pasig River

Elevation is above DPWH Datum.

Source DHWH: DPWH, Project for Pasig-Marikina River Flood Control, 2002.
OMWL: Pump operation records provided by MMDA

C.4.2 INUNDATION SURVEY AND MAPPING

Interview survey was conducted during October 2004 in order to grasp the inundation condition on 25 August 2004. Totally 1,000 respondents have been interviewed within the low-lying area of the core area of Metropolitan Manila. The item of the interview survey was mainly maximum depth and duration of inundation. Flow direction, speed of water level change and causes of the inundation have also been asked as supplementary information.

The survey points are shown in *Figure C.4.3* with maximum inundation depth. Based on those point data, contour maps for inundation depth and duration have been arranged using GIS. Estimated total area that has more than 20 cm maximum inundation depth is about 14.3 km^2 (about 20 % of the study area). This is smaller than the inundation in 1999.

Figures C.4.4 and *C.4.5* show the contour maps of maximum inundation depth and duration, respectively. The maximum inundation depth is around 1.0 m, which appears mainly along España Street. The area in which depth of inundation is deeper than 0.5 m extends widely in the central part of North Manila. Duration of inundation in this area is almost 12 hours. In South Manila, regional inundation area in which maximum depth exceeds 0.5m is not observed. Local deep inundation area exists, however.

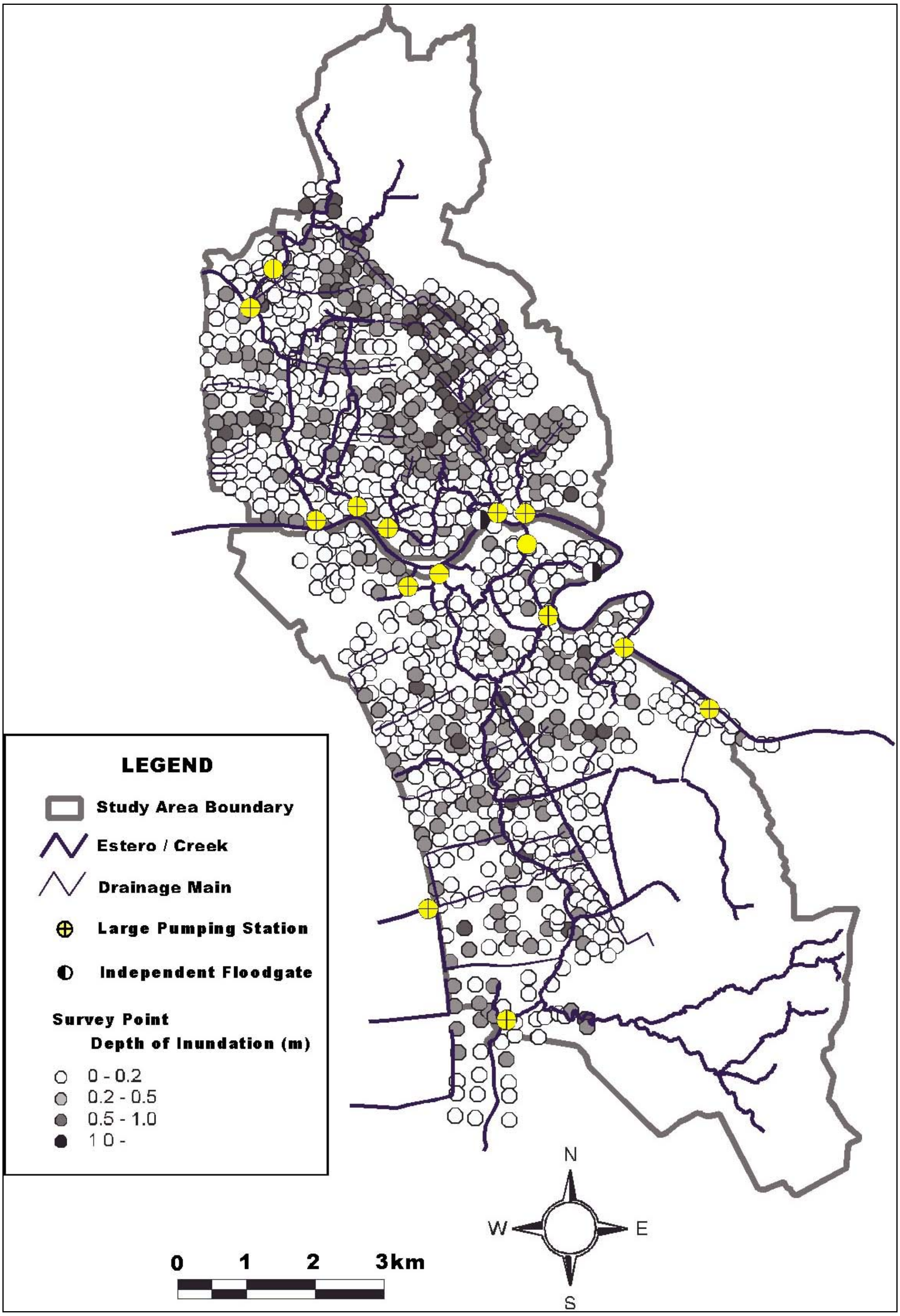


Figure C.4.3 Survey Points for Interview Survey on August 2004 Inundation

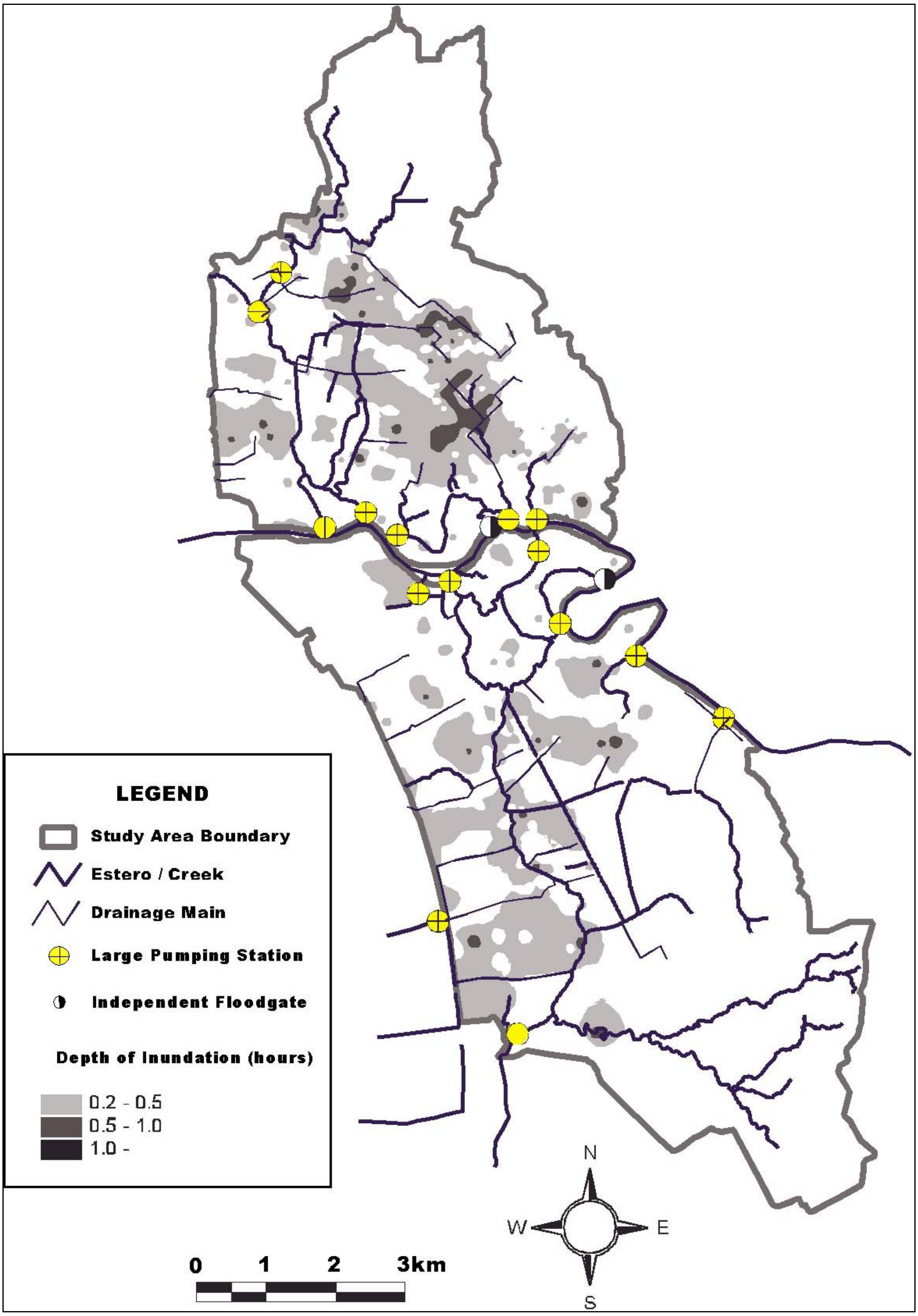


Figure C.4.4 Maximum Depth in August 2004 Inundation

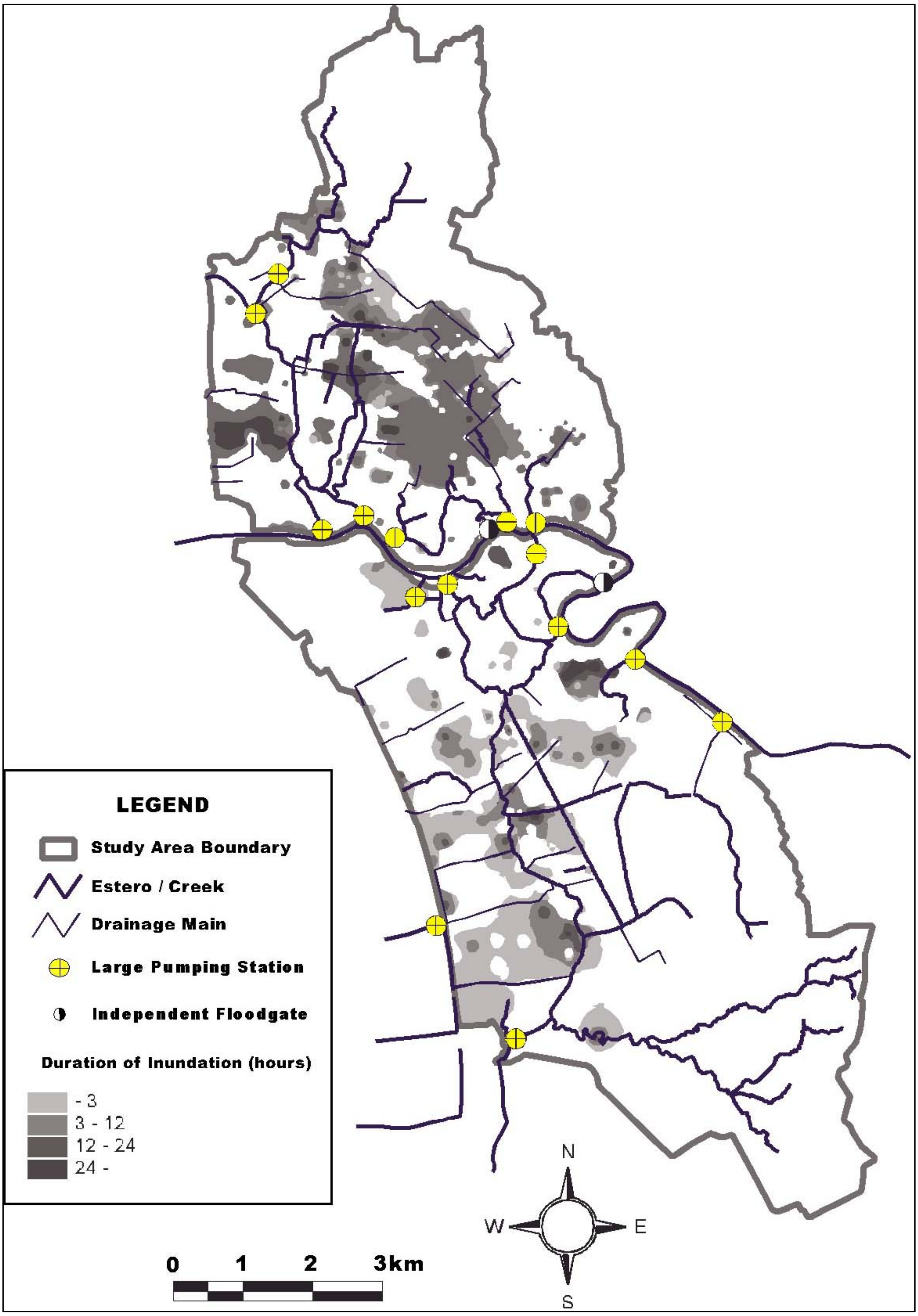


Figure C.4.5 Duration in August 2004 Inundation

C.4.3 PUMP OPERATION

Table C.4.4 shows summary of pump operation during August 2004 inundation. In the table, total volume of drained water at pumping station was estimated by assuming that pump efficiency is 100%. Estimated total volume of drained water per drainage area at pumping stations in North Manila is much larger than that in South Manila. This is presumably because of the difference of rainfall amount between North Manila and South Manila.

In North Manila, pumping stations in Quiapo - Aviles drainage block drained much more water per area than that in Vitas-Binondo-Escolta drainage. The difference (about 150 mm) is larger than the difference between rainfall amount at Port Area and Science Garden (about 50 mm). As discussed in chapter describing drainage system, existing Blumentritt interceptor has almost zero drainage capacity, which may result that almost all excess storm water in the upper drainage basin of the existing Blumentritt interceptor enters to Quiapo - Aviles drainage block. The records of pump operation during August 2004 support this.

According to the pump operation records, no floodgates at pumping stations were opened during August 2004 inundation.

C.4.4 NEWSPAPER REPORT

Many newspapers reported the inundation occurred in August 2004. *Table C.4.5* shows headline and summary of newspaper contents related to the inundation in the Metro Manila in August 2004. Many reported effects of solid waste and encroachment of informal settlers in esteros on inundation and how to treat those.

Table C.4.4 Summary of Pump Operation during August 2004 Inundation

Drainage Block	Pumping Station	Area (km^2)	Total Capacity (m^3/s)	Pump Unit (m^3/s)	Total Operation Hour (hr)*1		Total Volume (m^3)	Total Volume/Area (mm)	PumpStart Level (m)	Max. WaterLevel In Estero (m)*1	WaterLevel Rise in Estero (m)
					25-Aug	26-Aug					
N01	Vitas	5.69	32.0	6.400	48.25	25.75	1704960	294	10.1	10.40	0.30
	Binondo	2.56	11.6	2.900	18.18	56.47	779346		10.0	10.90	0.90
	Escolta	0.30	1.5	0.500	17.00	0	30600		10.0	10.90	0.90
N02	Quiapo	2.29	10.8	2.370	70.23	39.28	934339	443	10.5	10.85	0.35
	Aviles	3.28	15.6	3.530	73.31	47.28	1532458		10.5	11.45	0.95
N03	Valencia	2.37	11.8	2.625	56.64	45.3	963333	406	10.5	11.50	1.00
N04	Balut	0.49	2.0	1.000	29.50	20.75	180900	369	9.1	11.42	2.32
S01	Tripa de Gallina	17.06	57.0	7.000	47.36	39.92	2199456	165	9.9	10.60	0.70
	Libertad	7.52	42.0	7.000	39.75	33.87	1855224		9.9	10.20	0.30
S02	Balete	0.94	3.0	0.400	43.87	27.33	102528	109	10.6	11.45	0.85
S03	Paco	1.74	7.6	2.530	24.71	19.11	399113	166	10.5	10.75	0.25
	Pandacan	1.15	4.4	2.200	8.57	8.33	133848		10.5	10.85	0.35
	San Andres	3.12	19.0	4.750	15.47	11.72	464949		10.5	10.45	-
S04	Sta.Clara	1.63	5.3	2.650	14.19	9.89	229723	141	11.2	11.70	0.50
S05	Makati	1.65	7.0	3.500	8.23	5.96	178794	108	11.3	11.25	-

Source *1: MMDA
Note: Total volume is estimated by assuming that pump efficiency is 100%.

Table C.4.5 Newspaper Report during August 2004 Inundation

No	Date	Source	Headline	Contents
1	25-Aug	Inquirer	Arroyo postponed town hall meeting due to heavy rain	The President postponed "Pulong Bayan" scheduled to be held at Petron depot in Manila as a result of heavy rains brought by Typhoon Aere which was spotted 560 km north of Basco, Batanes.
2	25-Aug	Inquirer	Down pour floods metro, forces suspension of classes, flight	Heavy rains battered Metro Manila overnight causing flooding in low lying areas forcing the suspension of classes and cancellation on some international flights. The most flooded areas are España Ave., Taft Ave., Tayuman St. in Manila and Quezon Avenue and East Ave. in Q.C.
3	26-Aug	Inquirer	6-hour downpour swamps Metro Manila; 6 killed	Yesterday downpour lasting for about six hours was so heavy with an estimated amount of rainfall of about 136 mm or with an equivalent to the normal amount of rain for the whole month of May. As a results, six people were either dead or missing and about 20,000 residents of MM fled their homes, suspension of classes, closure of many offices and cancellation of flights. The waist deep flood in some low lying areas was induced by Typhoon Aere which is now spotted at 1800 km east of northern Luzon.
4	26-Aug	Inquirer	Heavy rains trigger floods, close roads	The flooding induced by Typhoon Aere caused not only the closure of major roads in Central Luzon but also left eight peole dead and more than 60,000 people evacuated from their homes.
5	26-Aug	Inquirer	Arroyo seeks to decongest Metro Manila due to flooding	The President's observation during her inspection of Pandacan Flood Control and Pumping Station served as the wake-up call for the government to intensify efforts in decongesting MM by relocating residents in flood prone areas. She said that "the flooding in MM only strengthens our resolve to decongest the metropolis and relocate those families dwelling in flashflood danger zones to afar ground, aside from further improving our anti-flood measures and drainage systems." She added that "These efforts are already in place and shall be sustained by the Teamwork of the national and local government".
6	26-Aug	Inquirer	Garbage a major culprit in Metro Manila floods	MMDA Chairman Bayani Fernado said that floodings in MM can be attributed not only to heavy downpour but especially to the indiscriminate disposal of garbages along water-ways and to the informal settlers that reduces discharge capacity. In effect, he said that they will strictly enforce the door-to-door collection of garbage to enhance the performance of the agency's pumping stations.
7	26-Aug	Manila Bulltein	8 dead as floods hit Luzon	Classes and offices were suspended due to monsoon rains and floods affecting largely the MM area and Central Luzon. Further, at least eight (8) people were killed while several others were injured and others missing based on reports reaching the NDCC. The waist deep flooding also resulted in the evacuation of thousands of families from their homes, closure of major thoroughfares and damages to properties.
8	26-Aug	Manila Bulltein	Heavy rains inundate Metro Manila Street	It was observed that despite an assurance of 75% flood control improvement by MMDA, heavy rains resulted to waist deep floodings in the low lying areas and major roads in Metro Manila.
9	26-Aug	Manila Bulltein	Relief personnel deployed at the height of heavy rains	Following orders from Manila Mayor Lito Atienza, the Manila City DCC Team were immediately deployed to carry-out relief and rescue operations around the flood affected areas. Several families living along Geronimo St. in Sampaloc were evacuated to Tecson Elemtary School as a precautionary measures for flood water running along Estero de Kalub which is parallel with the said street.
11	26-Aug	PhilStar	Marce" leaves eight dead	At least eight (8) people were feared dead while three (3) others were missing as overnight heavy rains caused by two (2) typhoons triggered floods, landslide affecting several parts of the country. The flooding in MM is about three feet deep in nearby Rizal and Bulacan. Most major roads were closed in the two provinces. Likewise, international flights to Taipei and a cargo flight originating from other countries were diverted to NAIA due to bad weather and domestic flight from Manila to Basco was stranded. The President canceled a planned town hall meeting in Pandacan and instead inpsected flood control projects. She instructed MMDA Chairman Bayani Fernando to enforce the door-to-door garbage collection policy as she observed that indiscrimate dumping of garbages along esteros is one of the major causes which reduced the discharge capacity.
12	27-Aug	Inquirer	PAGASA expects more rains	PAGASA forecasts and warns the public to expect more rains from two weather disturbances hovering the Philippine Area of Responsibility.

[1] JICA, DPWH, MMDA, Final Report on Study on the Existing Drainage Laterals in Metro Manila in the Republic of the Philippines (SEDLMM), 2000.
[2] MMDA, Statistical Data Flood-Prone Major Roads in Metro Manila, 2004.
[3] DPWH, Main Report on Detailed Engineering Design of Pasig-Marikina River Channel Improvement Project, 2002.
[4] JICA, MMDA, PHIVOLCS, Draft Final Report on Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines (MMEIRS), 2004.