【　資　　料　】

1.　　調査団員・氏名

［現地調査時］

氏　　名	担当業務	所 属 先
永田　謙二	総括	JICA　国際協力総合研究所　国際協力専門員
米林　徳人	計画管理	JICA　無償資金協力部第三ｸﾞﾙｰﾌﾟ水資源・環境ﾁｰﾑ
山本　敦彦	業務主任／排水計画／維持管理	株式会社ﾊﾟｼﾌｨｯｸｺﾝｻﾙﾀﾝﾂｲﾝﾀｰﾅｼｮﾅﾙ
今井　敏勝	排水路計画／水文解析	いであ株式会社
常磐　元司	排水設備計画１（機械）	株式会社ﾊﾟｼﾌｨｯｸｺﾝｻﾙﾀﾝﾂｲﾝﾀｰﾅｼｮﾅﾙ
船場　和典	排水設備計画２（電気）	いであ株式会社
小沢軍次郎	調達計画／積算	株式会社ﾊﾟｼﾌｨｯｸｺﾝｻﾙﾀﾝﾂｲﾝﾀｰﾅｼｮﾅﾙ

［基本設計概要説明調査時］

氏　　名	担当業務	所 属 先
永田　謙二	総括	JICA　国際協力総合研究所　国際協力専門員
井上　啓	計画管理	JICA　無償資金協力部第三ｸﾞﾙｰﾌﾟ水資源・環境ﾁｰﾑ
山本　敦彦	業務主任／排水計画／維持管理	株式会社ﾊﾟｼﾌｨｯｸｺﾝｻﾙﾀﾝﾂｲﾝﾀｰﾅｼｮﾅﾙ
小沢軍次郎	調達計画／積算	株式会社ﾊﾟｼﾌｨｯｸｺﾝｻﾙﾀﾝﾂｲﾝﾀｰﾅｼｮﾅﾙ

2.　　調査行程

［現地調査時］

日順	月日	曜日	総括（JICA）	計画管理（JICA）	業務主任/排水計画/維持管理（山本敦彦）	排水路計画/水文解析（今井敏勝）	排水設備計画 1（常盤元司）	排水設備計画 2（船場和典）	調達計画/積算（小沢軍次郎）
1	3月1日	木			移動（成田→マニラ）				
2	3月2日	金			マニラ首都圏開発庁(MMDA) （インセプションレポート提出）				
3	3月3日	土			現地調査（現地調査項目の明確化）				
4	3月4日	日			現地調査（現地調査項目の明確化）				
5	3月5日	月			● インセプションレポートの説明、内容の協議・確認 ● 我が国無償資金協力システムの説明および今後の調査・協力の進め方留意事項、双方の役割分担等についての協議・確認 ● DPWH表敬、大使館表敬		● 対象排水機場のチェック ● 運営維持管理に関する調査		● 積算関連資料収集 ● 調達関連資料収集
6	3月6日	火			● プロジェクトの背景、目的、内容等に係る調査 ● プロジェクトと上位計画、他ドナー・機関等の援助動向との関連及び本案件の位置付けの確認 ● 相手国のプロジェクト実施体制・実行能力に係る調査 ● 既存資料の整理・現況確認 ● 自然状況確認 ● 排水路横断測量 ● 排水状況分析				
7	3月7日	水							
8	3月8日	木							
9	3月9日	金			● MMDAとの会議（上位計画、他ドナー・機関等の援助動向との関連および本案件の位置付けの確認 ● プロジェクト実施体制・実行能力調査				
10	3月10日	土			現地調査 団内会議（調査実施上での問題点の明確化、MMDAへの要請資料内容の明確化）				
11	3月11日	日	AM:成田（09：30）→マニラ（13：25）JL741 17:00:団内打ち合わせ		団内打合せ				
12	3月12日	月	11:00:MMDA長官　表敬・協議 13:30:MMDAとのミニッツ協議 16:00:JICA事務所　松浦所長　協議			● プロジェクト上位計画に関する資料収集 水文に関する資料収集	● 対象揚水機場の機械・電気部品のチェックと問題点把握 ● 運営維持管理に関するチェックと問題点把握		● 調達事情調査 ● 積算関連調査 ● 環境配慮資料調査
13	3月13日	火	09:30:MMDAとのミニッツ協議 14:00:サイト視察			● 水文状況の整理 事業効果に関する項目の整理			
14	3月14日	水	09:00:ミニッツ協議 15:00:ミニッツ署名 17:00:日本大使館　報告						
15	3月15日	木	09:30:JICA事務所　岩上次長　報告 PM:マニラ発（14:45）→成田着（19:45）JL742	09:30:JICA事務岩上次長報告 以降・バンバンガ案件調査	● プロジェクトの背景、目的、内容等に係る調査 ● プロジェクトと上位計画、他ドナー・機関等の援助動向との関連及び本案件の位置付けの確認 ● 相手国のプロジェクト実施体制・実行能力に係る調査 ● 既存資料の整理・現況確認 ● 自然状況確認 ● 排水状況分析 ● Warehouse、Workshop視察				
16	3月16日	金		別調査					
17	3月17日	土			現地調査 団内会議（調査結果の報告と必要対策項目の整理、現地調査報告書の作成に関する調整）				
18	3月18日	日							
19	3月19日	月			● 運営維持管理計画の整備及び事業効果の発現・持続性に係る項目の整理 ● 相手国側負担事業の実施に関する提言の整理 ● 無償資金協力事業の効果に係る評価、課題の提示及び協力実施への提言 ● その他の配慮事項に関する項目整理	● 水文状況の整理 ● 事業効果に関する項目の整理	● 必要部品の整理 （ポンプ、エンジン、バルブ、除塵機、補助機器およびスペアーパーツ）	● 必要部品の整理 （電気システム、スペアーパーツ）	● 積算関連資料整理 ● 環境配慮資料整理
20	3月20日	火							
21	3月21日	水							
22	3月22日	木			現地調査結果概要の作成				
23	3月23日	金			調査結果概要の説明、計画基本方針に関する協議・確認 大使館、JICA事務所、関連機関報告				
24	3月24日	土			移動（マニラ→成田）				

［基本設計概要説明調査時］

日順	月日	曜日	総括(JICA)	計画管理(JICA)	業務主任/排水計画/維持管理	調達計画/積算
1	10月14日	日	AM:成田（09：35）→マニラ（13：05）JL741 PM:団内打ち合わせ			
2	10月15日	月	09:00　JICA事務所打ち合わせ 10:30　大使館表敬 14:00　MMDA表敬 16:00　NEDA表敬			
3	10月16日	火	10:00　JBIC打ち合わせ	9:00　MMDA打ち合わせ 14:00　Department of Budget and Management（DBM）協議 16:00　現場視察		
4	10月17日	水		現場視察 16:00　Department of Finance（DOF）協議		
5	10月18日	木		09:30　ミニッツ協議 16:00　長官協議（Canceled） 18:00　JICA事務所協議		
6	10月19日	金		09:00　ミニッツ署名（Canceled） 14:00　JICA事務所報告 16:00　大使館報告		
7	10月20日	土	マニラ（14：25）→成田（19：50）JL742		現地補足調査	
8	10月21日	日			現地補足調査	
9	10月22日	月			マニラ（09:00）→成田（14:25）JL746	

3.　関係者（面会者）リスト

［現地調査時］

1) マニラ首都圏開発庁（Metropolitan Manila Development Authority: MMDA）

Bayani F. FERNANDO	長官（Chairman）
Cesar S. LACUNA	副長官
Robert C. NACIANCENO	General Manager
Martin Louis C. ONGPIN	長官直属私設コンサルタント
Baltazar N. MELGAR	Drainage and Waterways Division Chief, Flood Control Management Service
Michael D. DOCE	Pumping Stations and Flood Gate Division Chief, Flood Control Management Service
Elsie I. ENCARNACION	Head, Solid Waste Management Office
Patrocenio A. RANCAPERO Jr.	Plant Engineer, Aviles Sampaloc Pumping Station
Daniel O. LAGUNILLA III	Plant Engineer, Quiapo Pumping Station
Delfin D. FELICILDA	Plant Engineer, Tripa de Gallina Pumping Station
野崎　誠貴	JICA 専門家（都市開発行政アドバイザー）

2) 公共事業・道路省（Department of Public Works and Highways: DPWH）

Rebecca T. GARSUTA	Chief, Development Planning Division
堂薗　俊多	JICA 専門家（政策アドバイザー（治水行政））

3) The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA)

Susan R. ESPINUEVA	Chief, Dam Operation Unit, Flood Forecasting Branch

4) 環境天然資源省（Department of Environment and Natural Resources: DENR）

Eugenia L. LAGMAY	Assistant Director, Environmental Management Bureau

5) 国家経済開発庁（National Economic Development Authority: NEDA）

Joseph CAPISTRANO	JICA Desk Officer, Public Investment

6) 財務省（Department of Finance:）

Lina D. ISORENA	Executive Director, National Tax Research Center (NTRC)
Aida SIMBURIO	Assistant Commissioner, Tax Information Division

7) 世界銀行（The World Bank: WB）

Christopher R. ANCHETA	Operations Officer

8) 国連開発計画（United Nation Development Program: UNDP）

Edgardo A. POLICARPIO	Program Assistant, Environment

9) USAID

Dainel C. Moore	Chief, Office of Energy and Environment
Gil R.DY-LIACCO	Deputy Chief, Program Resources Management Office

10) 在フィリピン日本国大使館

坂井　康一	二等書記官

11) JBIC マニラ駐在員事務所

馬場　隆	駐在員

12) JICA フィリピン事務所

岩上　憲三	次長
鹿目　武	所員

［基本設計概要説明調査時］

1) マニラ首都圏開発庁（Metropolitan Manila Development Authority: MMDA）

Bayani F. FERNANDO	長官（Chairman）
Martin Louis C. ONGPIN	長官直属私設コンサルタント
Baltazar N. MELGAR	Drainage and Waterways Division Chief, Flood Control Management Service
Michael D. DOCE	Pumping Stations and Flood Gate Division Chief, Flood Control Management Service
Patrocenio A. RANCAPERO Jr.	Plant Engineer, Aviles Sampaloc Pumping Station
Daniel O. LAGUNILLA III	Plant Engineer, Quiapo Pumping Station
Delfin D. FELICILDA	Plant Engineer, Tripa de Gallina Pumping Station

2) 国家経済開発庁（National Economic Development Authority: NEDA）

Florante G. Igtiben	Chief, Asia & Pacific Division
Robert I. Domingo	Infrastructure Staff
Amy Dem Bemjamin	PIS

3) 予算管理省（Department of Budget and Management: DBM）

Ruby Estrban	Director

4) 財務省（Department of Finance: DOF）

Rommel S. Herrera	Assistant Director, Environmental Management Bareau

5) 在フィリピン日本国大使館

坂井　康一	二等書記官

6) JBIC マニラ駐在員事務所

馬場　隆	駐在員

7) JICA フィリピン事務所

松田　教男	所長
岩上　憲三	次長
鹿目　武	所員

4.　協議議事録

4.1　　現地調査時

MINUTES OF DISCUSSIONS
ON BASIC DESIGN STUDY
ON "THE PROJECT FOR METRO MANILA DRAINAGE SYSTEM URGENT IMPROVEMENT/UPGRADING"
IN REPUBLIC OF THE PHILIPPINES

In response to a request from the Government of Republic of the Philippines (hereinafter referred to as "the Government of the Philippines"), the Government of Japan decided to conduct a Basic Design Study (hereinafter referred to as "the Study") on the Project for Metro Manila Drainage System Urgent Improvement/Upgrading (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to the Philippines the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Mr. Kenji NAGATA, Senior Advisor, Institute for International Cooperation, JICA, and is scheduled to stay in the country from March 1 to 24, 2007.

The Team has held discussions with the officials concerned of the Government of the Philippines and is conducting a field survey in the study area.

In the course of the discussions and field survey, both sides confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Manila, March 14, 2007

Kenji NAGATA
Leader
Basic Design Study Team

Japan International Cooperation Agency

Bayani F. Fernando
Chairman
Metropolitan Manila Development Authority (MMDA)
Republic of the Philippines

ATTACHMENT

1. Name of the Project:

The Government of the Philippines requested to change the name of the Project to "THE PROJECT FOR URGENT IMPROVING / UPGRADING OF FLOOD CONTROL SYSTEM IN THE METORO MANILA".

2. Objective of the Project:

The objective of the Project is to reduce the losses of life and property of people through developing the capacities and functions of the existing pumping stations by improving and upgrading facilities of the stations.

3. Project Sites and Area Covered by the Project:

The requested sites of the Project are pumping stations located at "QUIAPO", "AVILES SAMPALOC" and "TRIPA DE GALLINA".

4. Responsible and Implementing Organization:

4-1) The responsible and implementing organization is "Metropolitan Manila Development Authority" (hereinafter referred to as "MMDA").

4-2) The implementing department in MMDA is "Flood Control Management Service".

4-3) Organization chart of MMDA is shown in Annex-1.

5. Items requested by the Government of the Philippines:

The Government of the Philippines requested components described in Annex-2 for the proposed Project including the project components in the original request. Regarding additional items, both sides understood that the Team would study them as much as possible. However some of them may not be able to be studied because of the Study schedule.

After discussions with the Team, the Government of the Philippines agreed that the Team would assess the contents of the components. Both sides agreed that based on results of the study, JICA would evaluate and finalize the components, then recommend it to the Government of Japan.

6. Prioritization and Selection for the Project:

The Team explained that the budget for the Project would be considered by the Government of Japan by evaluating the result of the study.

Both sides agreed that the contents of the Project, which are described in Annex-2, would be prioritized and selected from the technical consideration as well as in accordance with the budget allocated for the Project.

7. Japan's Grant Aid Scheme:

7-1) The Government of the Philippines understood the Japan's Grant Aid Scheme explained by the Team, as described in Annex 3-1.

7-2) The Government of the Philippines will take the necessary measures and allocate necessary budget properly, as described in Annex 3-2, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

7-3) The Team will clarify the necessary measures and budget to be taken by the Government of the Philippines, in addition to the general measures described in Annex 3-2, by further studies.

8. Schedule of the Study:

8-1) The consultant members of the Team will conduct further studies in the Philippines until March 24, 2007.

8-2) JICA will prepare the draft final report in English and dispatch a mission in order to explain its contents around August 2007 at the earliest if some measures described in this document such as VAT issue and EIA would be executed properly by the Government of the Philippines.

8-3) In the case that the contents of the report are accepted in principle by the Government of the Philippines, JICA will complete the final report and send it to the Government of the Philippines in around September 2007 at the earliest.

8-4) The Government of the Philippines understood that the implementation of the Study does not imply nor commit the implementation of the Project.

9. Tax and Value Added Tax (VAT) :

The Team explained the reason of suspension of the Grant Aid and strongly requested that the Government of the Philippines shall take necessary measures to pay the Value Added Tax (VAT), custom duties and any other taxes and fiscal levy charges in the Philippines arising from the Project activities and these taxes and charges would be borne by beneficiary agency in accordance with the implementation schedule.

The Government of the Philippines understood the background of suspension and promised to start necessary procedures for securing budgets for the refund of these taxes. The budgets will be arranged exclusively for the Project in accordance with the Project cost and scale.

The Government of the Philippines will inform the result or progress to the Team through JICA Philippine Office.

10. Other Relevant Issues:

10-1) Current Problems of the Pumping Stations and Flood Control System and Solution:

Both sides agreed that the Study is implemented with counterpart engineers of the Government of the Philippines to find out and confirm the current problems mutually.

The Government of the Philippines promised to solve the problem by themselves if the Project would not cover these problems and areas.

10-2) Operation and Maintenance of Facilities and Equipment:

The Team explained that improving the capability of operation and maintenance is important for the Project. The Team will evaluate the present capability of the system and propose measures, such as allocation of additional budget and qualified personnel required for the proper and effective utilization of facilities and equipment, if necessary.

The Government of the Philippines agreed to abide with the proposal of the Team as results of the Study, in accordance with the implementation schedule of the Project.

The Government of the Philippines explained the effort and progress in terms of operation and maintenance of the facilities and equipment such as rehabilitation of facilities.

The Government of the Philippines promised to keep on allocating the budget continuously for the operation and maintenance.

10-3) Technical Assistance:

The Government of the Philippines requested the technical assistance on improving the capability of operation and maintenance system for sustainable development such as capacity of observation and monitoring of equipment and facility.

The Team agreed to study its necessity and if it is confirmed, the implementation of the technical assistance as soft component program or training ~~in Japan~~ would be considered in the Project.

10-4) Activities by the Government of the Philippines related to the "Master Plan":

The Government of the Philippines explained activities and future plans to realize suggestions proposed in the "Master Plan of the Development Study on Drainage Improvement in the Core Area of Metropolitan Manila (2005)" such as dredging, resettlement of peoples and public education for cleaning the drain channel.

As examples of activities, the Government of the Philippines started opening pumping stations to the public to show how they function and how they should be taken care of in order for the public to appreciate the value of them.
The Government of the Philippines also explained they made 100 small boats to clean the drain channel that are inaccessible by larger dredgers and equipments.

10-5) Environmental Impact Assessment (EIA):

The Government of the Philippines agreed to complete the EIA or to get the corresponding equivalent document (e.g. Certificate of Non-Coverage) and get approval before the completion of the Explanation Mission of Draft Basic Design Report at the latest according to the relevant Philippines laws, regulations and guidelines, if it is required for the Project.

The Government of the Philippines also agreed to submit the official letter which shows the completion of EIA or equivalent documents.

10-6) Relevant Permission for the Project:

The Government of the Philippines will expedite necessary procedure before the Explanation Mission of Draft Basic Design Report, if the official approval or permission is required for the components of the Project. The Government of the Philippines also agreed to submit the official letter which shows the approval.

10-7) Arrangements for the Study:

As a response to the request by the Team, the Government of the Philippines agreed to arrange counterpart personnel for the Study, necessary arrangements such as working space for the Team and to provide promptly all the data and information relevant to the Project for the smooth implementation of the Study.

10-8) Safety and Security:

The Team explained that security measures are indispensable for effective study. The Government of the Philippines agreed to take necessary measures to secure the safety of the members of the Team.

The Team strongly requested that Counterpart personnel should accompany the Team especially for the field study and the Government of the Philippines agreed with this.

10-9) Lesson Learnt by the Past Cooperation by Japanese Official Development Assistance:

The Team requested to the Government of the Philippines that the outcome of technical transfer and the cooperation implemented by the Japanese government in the past should be utilized to improve the living condition of the Philippines people.

The Government of the Philippines agreed and promised to utilize the lesson learnt from the past cooperation.

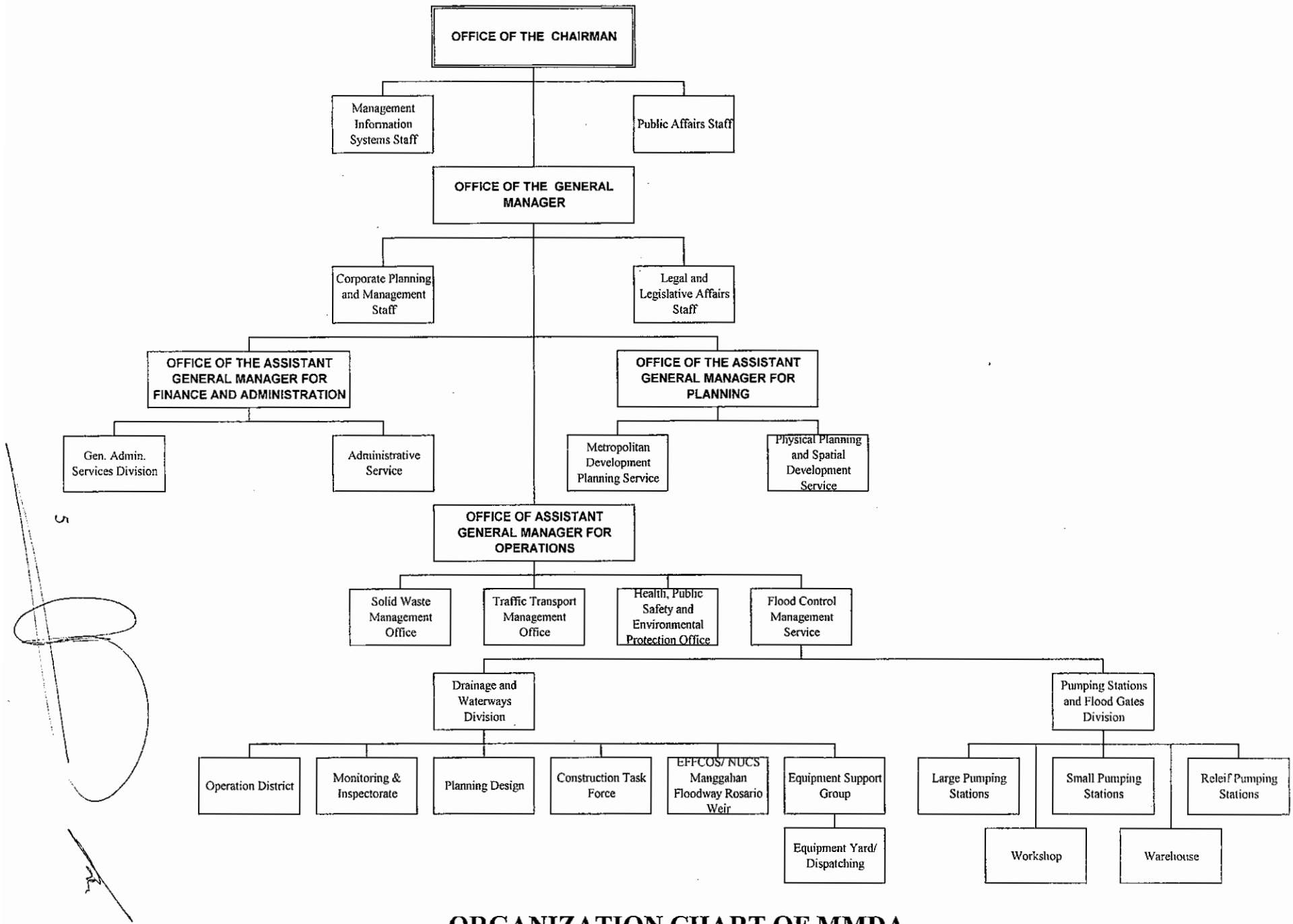
End

Annex 1 : Organization Chart of MMDA

Annex 2 : Items Requested by the Government of the Philippines

Annex 3 : 3-1 The Japan's Grant Aid Scheme

3-2 Major Undertakings to be taken by Each Government



ORGANIZATION CHART OF MMDA

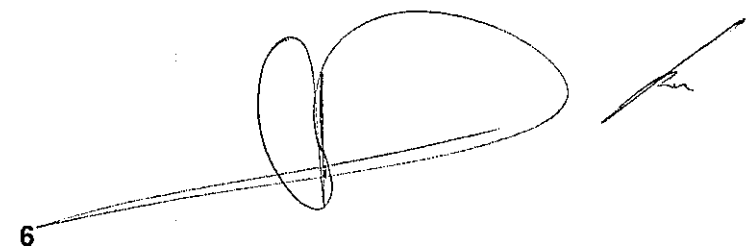
ANNEX 1

Items Requested by the Government of the Philippines

IMPROVEMENT OF MECHANIC AL AND ELECTRICAL EQUIPMENT IN THREE PUMPING STATIONS

ITEMS	QUIAPO	AVILES·SAMPALOC	TRIPA DE GALLINA
I. PUMP HOUSE			
1. Main Drainage Pump	○	○	●
2. Main Diesel Engine	○	○	●
3. Engine Cooling System	○	○	●
4. Overhead Crane	●	●	●
5. Electrical System	○	○	○
II. FLOODGATE			
Motorized Lifting System	●	●	●
III. TRASH COLLECTION SYSTEM			
1. Automatic Trash rakes	○	○	○
2. Horizontal/Inclined Conveyors	○	○	○
3. Sludge Pump	●	●	●
4. Hopper	○	○	○
5. Upstream Gate	●	●	●
IV. AUXILIARY SYSTEM			
1. Fire Detection and Control System	●	●	●
2. Security System	●	●	●
3. Fuel Supply System	○	○	○
4. Loader	●	●	●
V. Pickup Truck and Double Cab	○	○	○
VI. SPARE PARTS			
For Electrical and Mechanical Equipment/Devices	○	○	○

Notes; The symbol "○"indicates the components and items in the original request.
The symbol "●"indicates the components and items additionally requested.



Japan's Grant Aid Scheme

1. Japan's Grant Aid Scheme

The Grant Aid scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

2. Grant Aid Procedures

Japan's Grant Aid scheme is executed through the following procedures.

- Application	(Request made by a recipient country)
- Study	(Basic Design Study conducted by JICA)
- Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
- Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for the Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm (s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the recipient country.

Finally, for the smooth implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

3. Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereafter referred to as "the Study"), conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

- Confirmation of the background, objectives, and benefits of the requested project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.
- Preparation of a Basic Design of the Project.
- Estimation of cost of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even through they may fall outsides of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consulting firm (s). JICA selects (a) firm (s) based on proposals submitted by interested firms. The firm (s) selected carry (ies) out a Basic Design Study and write (s) a report, based upon terms of reference set by JICA.

The consulting firm (s) used for the Study is (are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

4. Japan's Grant Aid Scheme

1) Exchange pf Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

2) Period of the Grant Aid

"The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consulting firm (s) and (a) contractor (s) and final payment to them must be completed.

However, in case of delays in delivery, installation or construction due to unforeseen factors such as natural disaster, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

3) Procurement of Products and Services

Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely, consulting constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

4) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

5) Undertakings required to the Government of the Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

① To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction,
② To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,
③ To secure buildings prior to the procurement in case the installation of the equipment,
④ To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid,
⑤ To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,
⑥ To Accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

6) "Proper Use"

The recipient country is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

7) "Re-export"

The products purchased under the Grant Aid should not be re-exported from the recipient country.

8) Banking Arrangements (B/A)

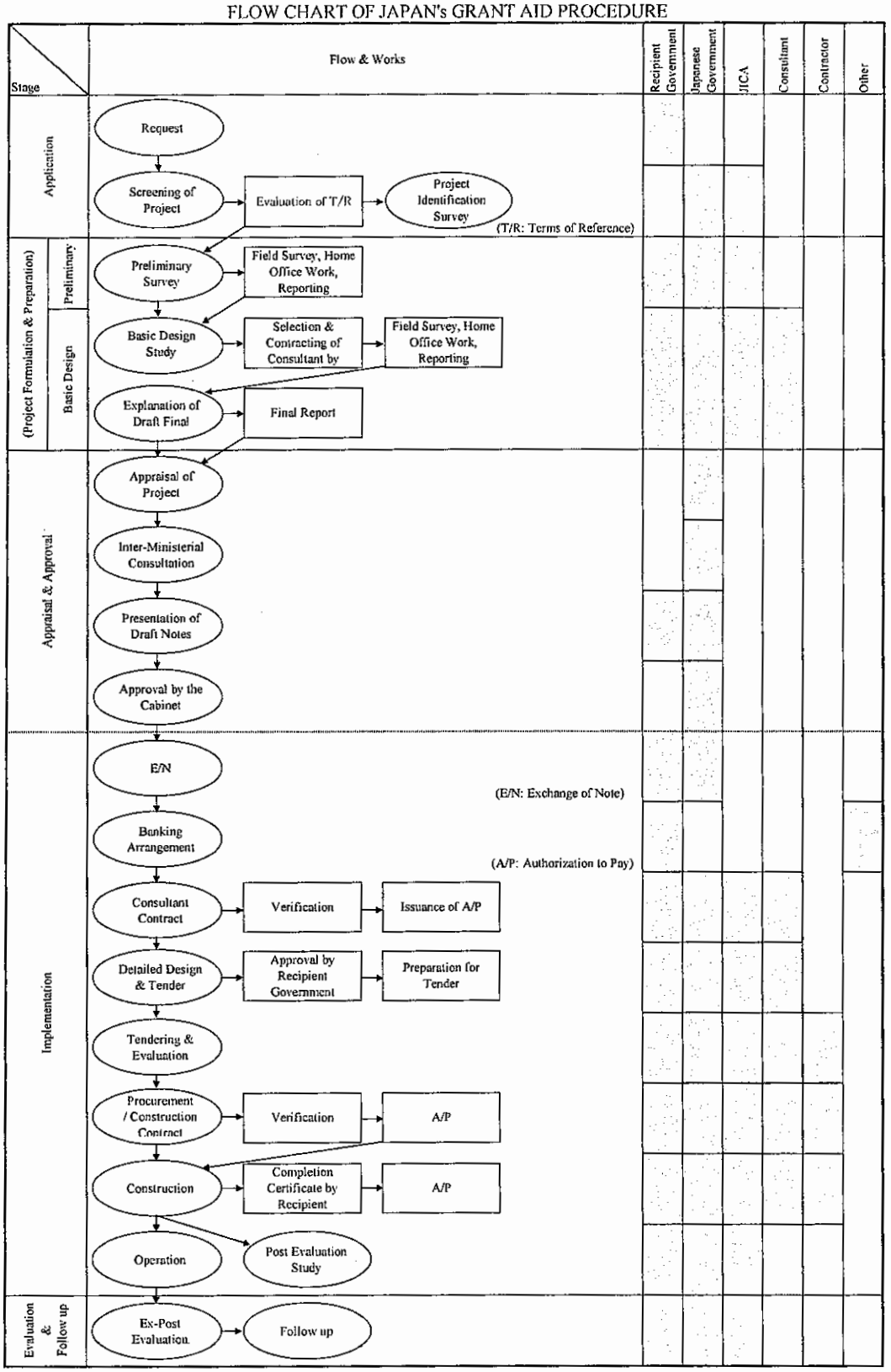
a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank of Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

FLOW CHART OF JAPAN's GRANT AID PROCEDURE



Major Undertaking to be taken by Each Government

REFFERENCE

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To bear the following commissions to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
2	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan the recipient	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the verified contract, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
5	To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant Aid		●
6	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment		●

(B/A: Banking Arrangement, A/P: Authorization to pay)

4.2　　概要説明時

For a better tomorrow for all.
Japan International Cooperation Agency
PHILIPPINE OFFICE

19 October 2007

CHAIR BAYANI F. FERNANDO
Metropolitan Manila Development Authority
MMDA Building, Orense St., EDSA
Makati City

Dear Chair Fernando,

We are pleased to forward herewith, a copy of the Draft Final Report of the Basic Design Study on the "Project for Urgent Improving/Upgrading of Flood Control System in Metro Manila". The Project is being proposed by the MMDA for possible Japan's Grant Aid.

As you may note in the Report, the contents of the Basic Design Study were based on the agreements during the discussions of the Basic Design Study Team and the MMDA representatives in March 2007. Said agreements are likewise stipulated in the Minutes of Discussion which the Chair and Mr. Kenji Nagata, leader of the Basic Design Study Team signed on 14 March 2007 (Appendix of Draft Final Report.)

As Mr. Nagata has already informed the Chair, JICA intends to implement the Project soonest time possible. Attached, for your further consideration, is the Minutes covering the discussions between the MMDA and the Explanation Team for the Basic Design Study of the subject Project from 15-19 October 2007.

Should you find the Minutes of Discussions in order, please inform our office as soon as possible, so we could initiate the project implementation.

Thank you and we look forward to your usual cooperation on the matter.

40th Floor, Yuchengco Tower, RCBC Plaza, 6819 Ayala Avenue, Makati City 1200 Philippines
P.O. Box 1026, Makati Central Post Office
Tel. No.: (+632) 889-7119 Fax. No.: (+632) 889-6850
JICA Homepage: http://www.jica.go.jp/philippines

Best regards.

Very truly yours,

NORIO MATSUDA
Resident Representative

And

KENJI NAGATA
Leader, Explanation Team
for the Basic Design Study

cc: Director Jonathan L. Uy, NEDA Public Investment Staff
Minister Akira Sugiyama, Embassy of Japan

MINUTES OF DISCUSSIONS
ON BASIC DESIGN STUDY
ON "THE PROJECT FOR URGENT IMPROVING/UPGRADING OF
FLOOD CONTROL SYSTEM IN METRO MANILA"
IN REPUBLIC OF THE PHILIPPINES
(EXPLANATION OF DRAFT FINAL REPORT)

In March 2007, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on the Project for Urgent Improving/Upgrading of Flood Control System in Metro Manila (hereinafter referred to as "the Project") to Republic of the Philippines (hereinafter referred to as "the Philippines"), and through discussions, field survey, and results of technical examination in Japan, JICA prepared a draft final report on this study.

In order to explain and consult with the Government of the Philippines on the contents of the draft final report, JICA dispatched the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Kenji NAGATA, Senior Advisor, Institute for International Cooperation, The Team is scheduled to stay in the country from October 14 to 22, 2007.

In the course of discussions and field survey, the Team and Metropolitan Manila Development Authority (hereinafter referred to as "both sides") confirmed the main items described in the attached sheets.

Manila, October 19, 2007

Kenji NAGATA	Bayani F. Fernando
Leader	Chairman
Draft Report Explanation Team	Metropolitan Manila Development Authority (MMDA)
Japan International Cooperation Agency	Republic of the Philippines

ATTACHMENT

1. Title of the Project

Both sides agreed to rename the title of the Project as "The Project for Urgent Improving/Upgrading of Flood Control System in Metro Manila", in compliance with the request made by the Philippine side. Final decision on the title will be made when both Governments sign the Exchange of Notes for the Project.

2. Components of the project

The Philippine side agreed and accepted in principle the components of the draft final report.

3. Japan's Grant Aid Scheme

3-1) The Philippine side understood the Japan's Grant Aid Scheme and will take the necessary measures and allocate necessary budget properly for smooth implementation of the Project, as a condition for the Japan's Grant Aid to be implemented. The Grant Aid Scheme and necessary measures were described in the Annex of the Minutes of Meeting agreed by both sides on March 14, 2007 (hereinafter referred to as "the Previous M/M").

3-2) Measures for "Other Relevant Issues" in this document, should be timely and properly undertaken by the Philippine side since these are indispensable to the whole Project Design. The Team explained that if the measures will not be taken properly, the approval of the Project would be reconsidered including cancellation by the Government of Japan.

4. Schedule of the Study

JICA will complete the final report in accordance with the items and confirmed by both sides and send it to the Government of the Philippines in December 2007 at the earliest.

5. Cost Estimation

Both sides agreed that the Project Cost Estimation as attached in Annex-1 should never be duplicated or released to any outside parties before the signing of all the Contract(s) for the Project.

Regarding the cost to be borne by the Philippine side, the Team requested the Philippine side to secure the appropriate and necessary amount of budget.

6. Other Relevant Issues:

The Team requested the Philippines side to carry out following matters;

(1)Taxes Arising from the Project

The Team explained again the background of suspension of the Grant Aid for the Philippine as written in the previous M/M.

The Team explained the rough cost estimate of the VAT and custom clearance fee to be borne by the Philippine side. However, other taxes such as national internal revenue taxes and import duties are not clear for the Japanese side. The Team requested to secure the appropriate and necessary amount of budget to pay the Value Added Tax (VAT), custom clearance fee and any other taxes and in the Philippines.

The Team also requested the Philippine side to report following matters in writing by the end of February in 2008.

- The result of budget allocation for VAT and custom clearance fee to be borne by the Philippine side.
- Estimation and breakdown of any other taxes.
- Information and schedule of reimbursement procedure for Japanese Consultant and Contractor.

The Philippine side committed to arrange the budget for the Philippine fiscal year 2009-12 in accordance with the Project cost and schedule, and submit the reports on the subject above mentioned.

(2)Operation rules of the pumping stations

The Team found that currently "no rainfall no operation" policy has been employed. It means pumps are operated simultaneously only when there is a possibility of rainfall even though water level is higher than pump starting level.

The Team pointed out that the current rule of operation is very risky and flooding at upstream might not be avoided. Therefore the Philippines side should apply appropriate operation rules of pumping stations in accordance with water levels.

The Philippine side agreed to the Japanese proposal and promised to take necessary measures.

(3)Proper implementation of custom clearance and safekeeping of equipment and materials

The Team explained that the shipping of equipment and materials will be done twice during implementation period of the Project and requested the Philippine side to properly carry out smooth custom clearance.

The Team also requested the Philippine side to properly secure the storage space at the Libertad warehouse because the equipment and materials will be brought to the Libertad warehouse and will be classified for each drainage pumping station from containers.

(4)Anticorrosive coat

The Team requested the Philippine side to carry out the application of anticorrosive coat of parts which have been identified needing such application after completion of the Project, even though parts are not to be replaced or renewed.

(5)Clearance of existing equipment and materials

Both sides confirmed again that the replaced equipment and materials to be replaced in the Project should be re-used or cleared out by the Philippine side.

(6)Fair Implementation of the Project

The Team explained that some information in both the draft and the final reports of the Study should be dealt with confidentially until the tender is closed, since disclosure of the information will affect fairness of tender procedure when the project proceeds to actual implementation stage.

The Philippine side understood and agreed on careful handling of the reports and achieving fair tendering.

END

Confidential

Annex-1 Project Cost Estimation

1.1 Initial Cost Estimation

Initial cost of the Project is estimated as 1,352 million Japanese Yen. According to estimation conditions that are mentioned below in item (3), breakdown of expense on Japanese side and the Philippines side is calculated based on the division of responsibility which is mentioned in a previous chapter. However, this amount does not suggest funding sources or amount of the Exchange of Note (E/N).

(1) Cost Borne by Japanese Side

Total Initial Cost			Approx. 1,197 million JY
Item of Expenses		Estimated Project Cost (million JY)	
Procurement Costs	Equipment Cost	839	1,144
	Transportation and Packing Cost	13	
	Installation Works Cost	227	
	Procurement Management Cost	32	
	General Administration Cost	33	
Detail Design/ Procurement Supervision/ Technical Transfer			53

(2) Cost Borne by Philippine Side 64.02 million Pesos (Approx. 154.6 million JY)

① Rental Const on Temporary Storage Yards 800,000 Pesos (Approx. 1.9 million JY)

② Removal and Relocation Cost of Existing Facilities 60,000 Pesos (Approx. 0.1 million JY)

③ Security Measures Cost 1.800 million Pesos (Approx. 4.4 million JY)

④ Banking Arrangement Charge 490,000 Pesos (Approx. 1.2 million JY)

⑤ VAT and Custom Clearance Fee 60.87 million Pesos (Approx. 147.0 million JY)

Note: Any other taxes such as national internal revenue taxes and import duties are not included.

(3) Estimation Conditions

① Conditions : As of March in 2007

② Exchange Rate : 1US$= 119.60 JY
: 1US$= 49.18 Peso
: 1Peso= 2.42 JY

③ Procurement Period : Period of bidding, procurement of equipment and materials, installation works is shown in the implementation schedule as a B type national bonds project

④ Others : Estimation is carried out based on Japan's Grant Aid system

1.2 Operation and Maintenance Cost

Drainage pumping stations which shall carry out procurement and installation works by the Project shall be operated and maintained by PSFO as mentioned in "Chapter 4 Project Operation Plan". Annual operation and maintenance cost is estimated as 24.995 million Peso (Approx. 60.513 million JY) (Refer to Table 2-1). Operation and maintenance cost is divided into management cost such as personnel expense, fuel cost, electrical and water fee, etc., and O&M cost. Budget should be secured taking escalation in personnel expense and prices into account in order to be operated without any problem in 2020 which is the target year.

Table 2-1 O&M Const of Target Drainage Pumping Stations (Annual)

Expense Item		Amount (Pesos)
Management Cost	Quiapo Drainage Pumping Station	3,617,000
	Aviles・Sampaloc Drainage Pumping Station	4,420,000
	Tripa de Gallina Drainage Pumping Station	6,545,000
	Sub-total	14,582,000
O&M Cost	Quiapo Drainage Pumping Station	2,056,000
	Aviles・Sampaloc Drainage Pumping Station	2,461,000
	Tripa de Gallina Drainage Pumping Station	5,896,000
	Sub-total	10,413,000
Total		24,995,000

5.　事業事前計画表（基本設計時）

事業事前計画表（基本設計時）

1. 案件名

フィリピン共和国　メトロマニラ排水機能改善計画

2. 要請の背景

・「フィ」国は、面積当たりの自然災害発生頻度（1966-90 年の 1 万平方キロあたりの発生数）で、地震災害が世界第 2 位、洪水及び火山災害が第 4 位という、世界有数の自然災害国で、年平均 700 人以上の人命が失われ、150 億円以上の被害を出している。毎年 20 個程度の台風が「フィ」国を取り巻く地域で発生し、近年の過密化の進行も相俟って洪水リスクが年々増加している。「フィ」国政府は、かかる状況を憂慮して、「中期フィリピン開発計画（2004-2010）」のなかで、災害被害の軽減対策を優先度の高い主要項目として位置づけている。これは、本プロジェクトの上位計画と位置づけられる。

・マニラ首都圏では、長年にわたり排水機場整備を主とする排水対策事業を実施してきたが、既存施設の老朽化、大量の固形廃棄物が排水機場に流入することによる過負荷運転が原因で、ポンプ、エンジン、排水バルブ、自動除塵機等、システム全体の劣化が著しく、洪水対策上危機的な状況である。

・本プロジェクトは、要請のあった 3 排水機場の機械系・電気系機材の更新、改良、修理を通じ、対象排水機場の機能改善がされ、洪水対策システムが整備されることを目的とする。また、ひいてはマニラ首都圏における社会・経済活動条件及び生活環境が改善することを上位目標とする。

3. プロジェクトの全体計画概要　※下線部：本無償資金協力に直接関係する成果、活動及び投入

(1)　プロジェクト全体計画の目標

・裨益効果：

３排水機場の所管地域の 23.46km2 に居住する 48 万人（2000 年）

・プロジェクト終了時に発現が期待される直接的な便益：

３排水機場所管地域の排水機能が向上し、当該地域における社会・経済活動条件及び生活環境が改善する。

(2)　プロジェクト全体計画の成果

・３排水機場施設の機能が改善される。

(3)　プロジェクト全体計画の主要活動

・マニラ首都圏中心地域に位置する３排水機場の改修工事及び追加工事が行われる。

(4)　投入（インプット）

・日本側（＝本案件）：　無償資金協力 12.02 億円

・フィリピン共和国側：　資機材仮置場費用、既存施設撤去・移設費、治安対策費、銀行取極（B/A）手数料、付加価値税（VAT）及び通関費等（155.5 百万円）、維持管理費を含む経費（64.2 百万円／年）

(5)　実施体制

実施機関：　本プロジェクトの主管官庁は、マニラ首都圏開発庁（MMDA）、実施機関は、洪水制御管理部（FCMS）である。

4. 無償資金協力の内容

(1)　サイト

・フィリピン共和国マニラ首都圏

(2)　概要

・対象排水機場であるキアポ、アビレス・サンパロック、トリパ・デ・ガリナ排水機場のポンプ、電気設備（ポンプ、主エンジン、自動除塵機、電気システム、補助機器、洪水ゲート吊り上げシステム、スペアパーツ）の機能回復に必要な資機材の調達・据付。

(3)　相手国負担事項

・資機材置き場の確保
・幹線道路からキアポ排水機場への動線の確保
・キアポ排水機場の入口の塀及び電柱の撤去
・撤去資機材の最終処分
・工事中の警備

(4) 概算事業費

・概算事業費 13.58 億円（無償資金協力 12.02 億円、フィリピン共和国側負担 1.56 億円）

(5) 工期

・2008 年 6 月から約 46 ヶ月（予定）

(6) 貧困、ジェンダー、環境及び社会面の配慮

特になし

5. 外部要因リスク

・気象変動等により、排水路に接続している河川の状況が著しく変化しない。

6. 過去の類似案件からの教訓の活用

特になし

7. プロジェクト全体計画の事後評価に係る提案

(1) プロジェクト全体の目標達成を示す成果指標

・排水機場の機能停止により発生する、洪水時の湛水量及び湛水面積が低減できる。

湛水量（千 m3）	
現　況 （2007 年）	事業実施後 （2013 年）
2,740	744

湛水面積（千 ha）	
現　況 （2007 年）	事業実施後 （2013 年）
4,493	2,013

(2) その他の成果指標

特になし

(3) 評価のタイミング

・2013 年以降（完工の 1 年後以降）

6.　　参考資料／入手資料リスト

様式第1号（記第2関係）

（収集／作成資料）

資料リスト（□収集資料／□専門家作成資料）

平成19年4月02日作成

主管部長	文書管理課長	主管課長	情報管理課長	技術情報課長	図書館受入日

		プロジェクト	メトロマニラ排水機能改善計画基本設計調査	調査団番号			
地域		調査団名又は専門家氏名		調査の種類又は指導目的	基本設計	担当部課	無償資金協力部業務第三グループ
国名	フィリピン国	配属機関名		現地調査期間又は派遣期間	19年03月01日~19年03月24日	担当者氏名	井上 啓

番号	資料の名称	形態(図書・ビデオ・地図・写真等)	収集資料	専門家作成資料	JICA作成資料	テキスト	発行機関	取扱区分	図書館記入欄
1	Medium-Term Philippine Development Plan 2004 - 2010	PDFファイル	○				NEDA	JR・CR（ ）・SC	
2	REPUBLIC ACT No. 7924	コピー	○				The House of Representatives	JR・CR（ ）・SC	
3	MEMORANDUM OF AGREEMENT between DPWH and MMDA	コピー	○				DPWH, MMDA	JR・CR（ ）・SC	
4	REPUBLIC ACT 9003 "The Ecological Solid Waste Management Act of 2000"	図書	○				National Solid Waste Management Commission	JR・CR（ ）・SC	
5	MEMORANDUM "FOUR POINT ACTION PLAN FOR DISASTER PREPAREDNESS"	コピー	○				National Disaster Coodinating Council	JR・CR（ ）・SC	
6	Presidential Decree 1586 "Philippine Environmental Impact Statement System"	図書	○				DENR	JR・CR（ ）・SC	
7	PROCEDURAL MANUAL FOR DAO 2003 - 30	Wordファイル	○				DENR	JR・CR（ ）・SC	
8	Exchange Rates : Philippine Peso per US Dollar 2006 to 2007	コピー	○				Bankers Association of the Philippines	JR・CR（ ）・SC	
9	Basic Unit cost of MMDA	コピー	○				MMDA	JR・CR（ ）・SC	
10	Unit Cost for Implementation by MMDA	コピー	○				MMDA	JR・CR（ ）・SC	
11	Operation Records on Quiapo, Aviles・Sampaloc, Trip de Gallina	コピー	○				MMDA	JR・CR（ ）・SC	
12	Overhaul/ Repair Records of Pumping Stations Equipment on Quiapo, Aviles・Sampaloc, Trip de Gallina	コピー	○				MMDA	JR・CR（ ）・SC	
13	Volume of Garbage Accumulated and Uncollected from Each Pumping Station	コピー	○				MMDA	JR・CR（ ）・SC	
14	Sparepats List of Pumping Station Equipment	Excelファイル	○				MMDA	JR・CR（ ）・SC	
15	STATUS REPORT ON PROJECTS FOR THE MONTHOF JANUARY TO DECEMBER 2006	コピー	○				MMDA	JR・CR（ ）・SC	
16	STATUS REPORT ON PROJECTS FOR THE MONTHOF JANUARY TO DECEMBER 2007	コピー	○				MMDA	JR・CR（ ）・SC	
17	SUMMARY OF WEATHER DISTURBANCES THAT PASSES THRU THE PHILIPPINE AREA OF RESPONSIBILITY FROM 1980 to 2006	コピー	○				MMDA	JR・CR（ ）・SC	
18	Supporting Islands of Good Governance Philippines	パンフレット	○				WB	JR・CR（ ）・SC	
19	EFFECTIVE FLOOD CONTROL OPERATION SYSTEM	図書	○				DPWH	JR・CR（ ）・SC	

20	EFCOS	図書	○				DPWH	JR・CR ( )・SC	
21	USAID PHILIPPINES HEALTH	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
22	USAID PHILIPPINES ENERGY AND ENVIRONMENT IN MINDANAO	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
23	USAID PHILIPPINES EDUCATION	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
24	USAID PHILIPPINES ASSISTANCE OVERVIEW	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
25	USAID PHILIPPINES ECONOMIC DEVELOPMENT & GOVERNANCE	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
26	Summary of United States- Philippines Development Partnerships for Fiscal Year (FY) 2006	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
27	USAID PHILIPPINES Promoting Peace and Prosperity in Mindanao	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
28	USAID PHILIPPINES PROGRAM OVERVIEW 2007	パンフレット	○				USAID PHILIPPINES	JR・CR ( )・SC	
29	ADB PRIVATE SECTOR OPERATIONS Strategic Directions and Review	図書	○				ADB	JR・CR ( )・SC	
30	ADB ANNUAL REPORT VOLUME 1	図書	○				ADB	JR・CR ( )・SC	
31	ADB PUBLICATIONS Marce 2006	図書	○				ADB	JR・CR ( )・SC	
32	ASIAN DEVELOPMENT BANK & PHILIPPINES A FACT SHEET	パンフレット	○				ADB	JR・CR ( )・SC	
33	UNDP Bulletin UNDP Internet UNDP Philippines 02 November 2006	コピー	○				UNDP	JR・CR ( )・SC	
34								JR・CR ( )・SC	
35								JR・CR ( )・SC	
36								JR・CR ( )・SC	
37								JR・CR ( )・SC	

7.　その他の資料・情報

A　　当該国の社会経済状況

フィリピン共和国	Republic of the Philippines

一般指標				
政体	立憲共和制		失業率	11.0%（2006）
元首	グロリア・マカパガル・アロヨ大統領		識字率	92.2%
独立年月日	1946 年 7 月 4 日		初等教育就学率	男性 113.2%、女性 111.5%
主要民族／部族名	マレー系、中国系、スペイン系、混血、少数民族		中等教育就学率	男性 81.6%、女性 90.3%（2004）
主要言語	フィリピノ語、英語		平均寿命	男性 67 歳、女性 73 歳
宗教	カトリック 83%、その他のキリスト教 10%、イスラム教 5%		人口密度	619.5km^2（首都圏地域 2000）
国連加盟年	1945 年 10 月 24 日		人口増加率	2.3%（1990～1999）
国土面積	299,404km^2		カロリー供給率	2,497kcal（2005）
総人口	8,310 万人（2005 年世銀データ）		乳児死亡率	56.7/1,000 人（6 歳未満 1995）
首都	メトロ・マニラ		人間開発指数	0.744（2000）

経済指標				
通貨単位	ペソ（Peso）		貿易量	
為替レート	1US$＝48.262（2007 年 3 月 30 日）		輸出額	469.9 億 US$（2006）
会計年度	暦年（1 月～12 月）		輸入額	515.2 億 US$（2006）
国家予算			輸出成長率	4.2%（2005）
歳入総額	14,807 百万 US$（2005）		輸入成長率	2.4%（2005）
歳出総額	17,733 百万 US$（2005）		主要輸出品	電子・電気機器、輸送用機器
総合収支	－2,916 百万 US$（2005）		主要輸入品	通信・電気機器、電子部品
ODA 受取額	総額 450.8 百万 US$（2004）		日本への輸出	10,479 億円（2006）
国内総生産	99,029 百万 US$（2005）		日本からの輸入	9,257 億円（2006）
一人当たりの GNI	1,320US$（2005）			
分野別 GDP 比	農業 14.3%（2005）		総資本形成率	対 GDP 比 15.1%（2005）
	工業 32.2%（2005）		貯蓄率	対 GDP 比 10.5%（2005）
	サービス業 53.4%（2005）		対外債務残高	対 GNI 比 66.8%（2004）
産業別成長率	農業 1.8%（2005）		DSR	16.7%（2005）
	工業 4.9%（2005）		物価上昇率	6.2%（2005）
	サービス業 6.4%（2005）			
実質 GDP 成長率	5.0%（2005）		国家開発計画	フィリピン中期開発計画

当該国に対する我が国の ODA 実績					（単位：百万 US$）
	2001 年	2002 年	2003 年	2004 年	2005 年
政府貸付金	146.77	181.13	367.53	94.61	201.21
無償資金協力	66.75	59.42	69.72	42.17	17.90
技術協力	84.70	77.47	91.53	74.60	57.33
合計	298.22	318.02	528.78	211.38	276.43

当該国への DAC 諸国からの援助実績											（単位：百万 US$）
暦年	1 位		2 位		3 位		4 位		5 位		合計
2002 年	日本	318.0	米国	78.6	濠国	31.7	蘭国	25.9	西国	19.0	509.1
2003 年	日本	528.8	米国	55.3	濠国	32.1	独国	27.8	西国	25.8	703.8
2004 年	日本	211.4	米国	79.5	独国	39.1	濠国	33.6	蘭国	16.9	433.4

当該国への国際機関からの援助実績											（単位：百万 US$）
暦年	1 位		2 位		3 位		4 位		5 位		合計
2002 年	CEC	20.5	IFAD	4.4	UNFPA	3.3	UNICEF	2.8	UNDP	2.3	36.2
2003 年	CEC	17.6	IFAD	4.3	UNFPA	3.7	UNTA	2.7	UNICEF	2.6	26.5
2004 年	CEC	17.8	GEF	4.8	UNFPA	4.5	UNTA	2.4	UNICEF	2.3	17.4

注：当該国への国際機関からの援助実績の合計が合わないのは、その他国際機関がマイナス計上されているため。

B　　雨量解析結果

B　雨量解析結果

1.　概　要

本雨量解析は、今回調査対象地域での流出検討において必要となる降雨強度継続時間確率曲線が、フィリピン国「マニラ首都圏中心地域排水機能向上調査」で 2004 年に確立された降雨強度継続時間確率曲線をそのまま使用できるのか、あるいはその後の降雨資料からアップデートが必要なのか否かの検討のために行ったものである。

2.　雨量観測所

本調査では、いくつかの観測所の時間雨量資料が得られたが、上記開発調査で使用された雨量観測所とは、“Science Garden”のみが共通していたので、この観測所の時間雨量資料の検討を行った。

3.　雨量資料

開発調査では、2003 年までの資料が使用されていたので、本調査では、2004 年以降の時間雨量資料を収集した。この時間雨量資料は表 3-1～3-36 に示すとおりである。

4.　時間雨量継続時間確率曲線

開発調査で確立された時間雨量継続時間確率曲線で、排水計画に使用された 10 年確率曲線は以下のようなものである。

$$I = \frac{1216}{(t+11)^{0.63}}$$

ここで、

I：降雨強度 (mm/hr)

t：降雨継続時間 (分)

開発調査で上記時間雨量継続時間確率曲線作成に使用された継続時間ごとの年最大雨量は、表 4-1 に示すとおりである。

5.　2004 年以降の追加資料

2004 年以降の時間雨量資料から得られた各継続時間（1 時間、2 時間、3 時間、6 時間、12 時間、24 時間）の年最大雨量も表 4-1 に示す。

6.　確率曲線

短時間降雨強度年最大値の確率解析は、上記で示す、2004 年以前と以降の資料を用いて行った。得られた確率曲線は、継続時間毎に、図 6-1～6-6 に示すとおりである。図から、2004 年以降のデータを使用しても、開発調査で確立された降雨強度継続時間確率曲線の変更は、本調査においても必要のないものと判断できる。

表 3-1 Hourly Rainfall at Science Garden in 2004

2004 Unit : mm

January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3

表 3-2 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																												
February	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
12 - 13	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
15 - 16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	0	0	0	0	0	0	13
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	24	2	1	1	0	0	0	31

表 3-3 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																															
March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

表 3-4 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																														
April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	10
14 - 15	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	18
15 - 16	0	0	0	0	0	0	0	18	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	25
16 - 17	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17 - 18	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
02 - 03	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	2	0	29	35	7	0	3	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	88

表 3-5 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																															
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	0	0	6	7	0	0	0	0	0	0	0	0	0	0	22
14 - 15	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	2	0	0	1	3	0	0	0	0	0	0	0	0	0	0	48
15 - 16	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	5	0	0	7	1	13	0	0	0	0	0	0	0	0	0	33
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	5	0	0	0	0	0	0	0	0	0	7
17 - 18	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	3	0	0	1	0	0	0	0	0	0	0	0	0	6
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	3	0	0	0	0	0	0	0	0	0	9
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	0	5
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	2	0	0	0	0	0	0	0	0	0	12
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	5
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
01 - 02	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	28
02 - 03	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0	12
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
04 - 05	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
* DAILY	0	0	0	0	0	0	14	3	50	1	0	0	0	1	0	0	20	1	23	15	16	62	0	0	0	0	0	0	0	0	0	206

表 3-6 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																														
June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	9
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	10	0	0	0	0	15
10 - 11	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	13	0	0	0	0	17
11 - 12	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	7
12 - 13	1	0	0	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
13 - 14	0	0	1	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	8
14 - 15	0	0	0	0	0	1	1	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12
15 - 16	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5
16 - 17	0	2	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
17 - 18	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
18 - 19	0	1	0	0	1	1	0	0	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
19 - 20	0	0	1	0	0	2	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
20 - 21	0	0	0	0	0	4	0	0	0	0	0	0	12	1	0	0	0	0	0	0	15	0	0	1	0	0	0	0	0	0	33
21 - 22	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	5
22 - 23	0	0	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	1	0	0	0	0	24
23 - 24	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	7
00 - 01	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
01 - 02	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
02 - 03	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
03 - 04	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	6
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2
05 - 06	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	6
06 - 07	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	3
07 - 08	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
* DAILY	7	6	4	9	14	22	5	2	0	1	0	11	13	5	0	2	0	0	0	23	19	3	7	9	8	24	0	0	5	3	202

表 3-7 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																															
July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	11
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	13	0	0	19
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	5	16	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	24
14 - 15	0	0	0	0	0	10	0	0	8	0	0	5	16	11	1	0	0	1	9	0	1	36	0	0	0	1	0	0	1	0	0	100
15 - 16	0	1	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	1	0	0	0	0	19	0	2	0	0	0	0	0	0	41
16 - 17	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	14	0	3	3	0	0	0	0	0	37
17 - 18	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	1	1	1	1	14	0	0	0	5	0	29
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	6	1	1	1	1	1	0	28	0	5	0	46
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	5
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	6
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
06 - 07	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	4
* DAILY	6	1	0	0	0	10	0	0	26	17	0	6	16	16	17	0	6	3	10	2	12	40	40	14	10	24	0	28	17	13	9	343

表 3-8 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																															
August	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	27
09 - 10	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	11
10 - 11	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	11
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	0	0	0	8
12 - 13	0	1	0	1	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	9
13 - 14	0	0	0	10	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	18
14 - 15	0	0	0	18	0	0	0	0	1	0	0	0	16	0	0	0	1	1	0	0	0	1	0	0	3	0	0	0	0	0	10	51
15 - 16	0	0	0	0	0	0	0	4	1	0	0	0	4	0	2	0	1	0	0	0	0	1	0	0	5	31	0	0	0	0	11	60
16 - 17	0	0	0	3	0	0	0	2	0	0	0	0	0	0	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7	18
17 - 18	0	0	0	28	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0	1	36
18 - 19	2	0	0	16	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	23
19 - 20	0	0	0	0	0	0	0	0	0	0	0	23	2	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	28
20 - 21	0	0	0	2	0	0	0	0	0	0	0	30	0	7	1	0	0	0	0	1	0	0	0	0	3	11	0	0	0	0	0	55
21 - 22	0	0	0	3	0	0	0	0	0	0	0	0	0	25	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	31
22 - 23	0	8	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0	0	0	4	2	0	0	0	0	0	20
23 - 24	0	8	0	0	0	0	0	0	0	0	0	0	0	4	7	0	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	25
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	2	17	0	0	0	0	1	0	0	0	0	2	6	0	0	0	0	0	28
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
02 - 03	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	11
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	12	1	0	0	0	0	0	50
04 - 05	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	10	0	0	0	0	0	0	41
05 - 06	0	0	5	0	10	0	0	0	0	0	0	2	0	0	0	0	5	0	0	0	0	0	0	9	2	2	0	0	0	0	0	35
06 - 07	0	0	1	0	7	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	49	5	0	0	0	0	0	0	66
07 - 08	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	33	2	0	0	0	0	0	0	38
* DAILY	2	17	6	82	28	1	6	14	5	0	0	58	31	43	36	4	18	1	0	3	1	3	0	158	103	54	0	0	0	0	29	703

表 3-9 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																														
September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
10 - 11	43	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	47
11 - 12	17	0	0	0	0	0	0	0	0	0	0	0	0	13	0	1	0	0	0	0	9	0	0	0	0	0	0	0	0	0	40
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	4	0	0	0	0	0	0	0	0	0	0	25
13 - 14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
14 - 15	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	19
15 - 16	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	27	0	1	0	0	0	0	4	0	37
16 - 17	0	0	0	0	0	0	2	0	0	0	0	0	*	0	16	0	0	0	0	0	0	0	18	0	0	0	0	0	5	0	41
17 - 18	0	0	0	18	0	0	0	0	0	0	0	0	*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
19 - 20	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3
21 - 22	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
22 - 23	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	15
23 - 24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
03 - 04	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
04 - 05	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	80	0	1	19	0	6	2	0	0	0	0	0	5	17	16	35	1	0	0	4	10	27	18	1	3	0	0	18	10	5	278

表 3-10 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																															
October	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0
12 - 13	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	7
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0
14 - 15	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
15 - 16	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	4
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
23 - 24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	8
00 - 01	23	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	31
01 - 02	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
02 - 03	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
03 - 04	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	32	1	7	0	0	20	2	8	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	83

表 3-11 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																														
November	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	*	0	0	0	0	0	0	0	2
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*	0	0	0	0	0	0	0	1
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	1	0	1
11 - 12	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	3
12 - 13	0	0	0	0	2	0	0	5	0	0	1	0	0	0	0	0	0	0	0	1	0	0	*	0	0	0	0	0	2	0	11
13 - 14	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	*	0	0	0	0	0	4	0	7
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
15 - 16	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	10
16 - 17	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	0	11
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	8	1	15
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	11	0	13
19 - 20	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	16	0	18
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	29
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	31
22 - 23	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	9
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
00 - 01	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	4
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
02 - 03	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
04 - 05	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
05 - 06	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
06 - 07	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
07 - 08	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	3
* DAILY	0	0	2	0	4	1	0	6	0	0	5	2	0	0	0	0	2	0	9	18	2	1	0	0	0	0	0	0	132	2	186

表 3-12 Hourly Rainfall at Science Garden in 2004

Unit : mm

2004																															
December	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
09 - 10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
15 - 16	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
16 - 17	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17 - 18	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
18 - 19	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
19 - 20	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
20 - 21	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
21 - 22	0	8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
22 - 23	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
23 - 24	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
03 - 04	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
04 - 05	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
05 - 06	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
06 - 07	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07 - 08	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
* DAILY	0	43	1	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54

表 3-13 Hourly Rainfall at Science Garden in 2005

2005 Unit : mm

January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
13 - 14	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	8

表 3-14 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																													
February	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
17 - 18	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		2
18 - 19	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
23 - 24	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
02 - 03	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		5
03 - 04	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
* DAILY	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		10

表 3-15 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																															
March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	6
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
04 - 05	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
06 - 07	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	1	9	0	0	0	0	0	0	0	0	0	0	0	0	0	14

表 3-16 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																														
April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	12	0	0	0	0	0	0	0	0	0	0	0	12
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	2	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
02 - 03	0	0	2	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	16	0	0	0	0	0	16
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	16	0	0	0	0	0	32

表 3-17 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																															
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	14
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	16	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	12	0	0	0	26	0	0	0	40
19 - 20	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0	23	0	0	0	0	0	0	0	29
20 - 21	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	8
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	2
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
02 - 03	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	7
03 - 04	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
04 - 05	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	0	0	0	2	5	0	0	6	0	0	0	0	3	0	0	0	0	2	0	36	1	1	1	66	0	2	4	129

表 3-18 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																														
June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
11 - 12	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
12 - 13	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
16 - 17	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	18
17 - 18	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	2	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	1	19	0	0	0	0	0	83
19 - 20	0	1	0	9	11	9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	8	13	0	0	0	0	0	64
20 - 21	0	0	0	1	4	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	25	1	0	0	0	0	1	0	45
21 - 22	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	10
22 - 23	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	13	0	0	0	29
23 - 24	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5	0	0	0	14
00 - 01	0	0	0	0	3	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	21
01 - 02	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	7
02 - 03	0	0	0	0	1	0	1	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	20
03 - 04	0	10	0	0	1	0	7	0	23	0	0	0	0	0	s	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	42
04 - 05	0	3	0	0	0	6	0	7	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	18
05 - 06	0	1	0	0	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
06 - 07	0	1	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	4	17	0	83	24	45	23	20	54	1	0	0	0	0	1	0	0	0	25	16	0	39	28	11	32	30	20	0	1	0	474

表 3-19 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																															
July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	12
09 - 10	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
10 - 11	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	10
11 - 12	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	11
12 - 13	0	0	0	2	8	0	0	0	6	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	27
13 - 14	0	0	0	0	2	0	0	0	4	0	0	7	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
14 - 15	0	0	0	0	2	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	14
16 - 17	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	9
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	12
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
20 - 21	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	5
21 - 22	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	10	0	0	0	0	0	0	0	14
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
23 - 24	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4
00 - 01	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
02 - 03	0	1	0	4	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
03 - 04	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	5
04 - 05	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
05 - 06	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
06 - 07	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
* DAILY	0	2	0	20	57	1	0	0	13	1	0	8	0	26	1	1	1	17	3	9	0	7	0	11	0	1	0	1	0	0	22	202

表 3-20 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																															
August	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
09 - 10	0	0	0	0	5	1	1	1	0	1	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
10 - 11	0	0	0	0	0	1	0	6	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	15
11 - 12	0	0	0	0	1	0	0	2	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	10
12 - 13	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
13 - 14	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
14 - 15	0	0	0	0	0	0	0	0	0	0	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
15 - 16	0	0	0	0	0	0	0	1	0	0	2	4	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	12
16 - 17	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	14	0	0	0	0	1	0	0	0	0	20
17 - 18	22	0	0	0	0	1	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	12	0	0	0	0	1	0	0	0	0	42
18 - 19	30	0	0	0	0	0	0	1	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	10	0	15	0	0	0	0	70
19 - 20	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	5
20 - 21	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	1	4	0	0	0	21
21 - 22	0	0	0	0	4	0	0	0	0	0	6	0	0	0	0	0	0	0	2	0	0	0	0	3	0	3	1	1	0	0	0	20
22 - 23	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	6
23 - 24	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
01 - 02	0	0	0	3	1	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	12
02 - 03	0	0	0	0	0	3	0	1	0	0	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
03 - 04	0	0	0	6	0	13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
04 - 05	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
05 - 06	0	0	0	0	3	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
06 - 07	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07 - 08	0	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
* DAILY	52	0	0	12	31	22	1	15	0	1	38	53	1	1	0	0	0	0	5	1	0	27	6	3	12	13	21	5	0	0	2	322

表 3-21 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																														
September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	*	*	0	0	0	0	0	0	1	0	0	0	0	0	0	5
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	3	0	0	0	0	0	0	3
10 - 11	6	0	0	0	0	0	21	0	0	0	0	0	0	0	0	*	*	0	0	0	0	0	0	3	0	0	0	0	0	0	30
11 - 12	1	0	0	0	0	0	5	0	0	0	0	0	0	0	4	*	*	0	0	0	0	0	1	0	0	0	0	0	0	0	11
12 - 13	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	*	0	0	1	0	0	0	0	8	0	0	0	0	0	0	14
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*	0	0	1	0	0	0	0	2	0	0	0	0	0	0	4
14 - 15	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6
15 - 16	0	0	1	0	0	0	0	0	0	0	0	0	1	0	8	*	0	1	0	0	0	0	0	1	0	0	0	0	0	0	12
16 - 17	0	0	9	0	0	0	0	0	0	0	0	0	0	24	2	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
17 - 18	0	0	3	0	1	0	0	0	0	0	0	0	0	2	19	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	3	1	0	0	0	0	0	0	0	22	0	4	16	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46
19 - 20	0	0	3	4	0	0	0	0	0	0	7	17	0	1	3	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
20 - 21	0	0	2	3	0	0	0	0	0	0	0	0	0	5	1	*	0	0	0	1	0	0	0	0	0	0	4	0	0	3	19
21 - 22	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
22 - 23	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	*	0	0	0	0	0	0	1	0	0	0	0	0	0	9	12
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
00 - 01	0	0	0	0	0	0	0	0	0	0	0	3	0	0	*	*	0	0	0	0	0	0	1	0	0	0	0	0	0	4	8
01 - 02	0	1	0	0	26	0	0	0	0	0	0	2	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0	2	0	0	31
02 - 03	0	19	1	0	3	0	0	0	0	0	0	3	0	0	*	*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	27
03 - 04	0	2	0	0	0	0	0	0	0	0	0	0	0	4	*	*	0	0	1	0	0	0	1	0	0	0	0	0	0	0	8
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	7	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
05 - 06	0	0	0	0	0	0	0	0	0	0	0	1	0	2	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
06 - 07	0	0	0	0	0	0	0	0	0	0	0	1	0	1	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
07 - 08	0	0	0	0	1	0	0	0	0	0	0	1	0	1	*	*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4
* DAILY	7	22	22	9	31	0	27	0	0	1	9	50	1	53	66	0	0	1	3	2	0	0	6	18	0	0	4	2	0	20	354

表 3-22 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																															
October	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	5
09 - 10	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4
12 - 13	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	9	0	2	0	0	0	0	24
13 - 14	0	0	0	0	0	0	0	6	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	14	0	2	0	0	25	0	69
14 - 15	0	0	31	0	0	0	0	6	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	13	0	57
15 - 16	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	12	0	0	0	0	0	0	1	0	0	4	0	21
16 - 17	0	0	1	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	39
17 - 18	0	0	0	0	0	5	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	17
18 - 19	0	0	0	0	0	0	6	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	10	0	26
19 - 20	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	8
20 - 21	0	27	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
21 - 22	0	11	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
22 - 23	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	41
23 - 24	0	0	0	0	0	0	4	0	0	12	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	28
00 - 01	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	16
01 - 02	0	1	0	0	0	4	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	18
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
03 - 04	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	10
04 - 05	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	9	0	0	0	0	11
05 - 06	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	0	9
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	5	0	0	0	0	10
07 - 08	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	8
* DAILY	2	40	34	4	0	51	52	17	1	13	4	39	1	0	0	10	0	2	1	12	0	0	1	0	24	5	97	6	0	55	0	471

表 3-23 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																														
November	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
11 - 12	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
12 - 13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13 - 14	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	29
14 - 15	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
15 - 16	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
16 - 17	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20 - 21	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	5
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3
07 - 08	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	6
* DAILY	6	0	1	0	10	1	0	1	0	7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	0	34	2	68

表 3-24 Hourly Rainfall at Science Garden in 2005

Unit : mm

2005																															
December	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12 - 13	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
13 - 14	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
14 - 15	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
15 - 16	0	0	0	0	0	0	0	3	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
16 - 17	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
17 - 18	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
18 - 19	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3
19 - 20	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	11
20 - 21	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
22 - 23	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
00 - 01	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
01 - 02	0	0	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
05 - 06	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
07 - 08	0	0	0	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
* DAILY	0	0	5	0	0	0	0	11	10	9	1	2	9	10	0	0	2	0	0	0	0	0	0	0	0	0	11	0	0	0	0	70

表 3-25 Hourly Rainfall at Science Garden in 2006

2006 Unit : mm

January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	6
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
13 - 14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	7
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	6
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	0	0	8
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3
* DAILY	2	1	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	11	22	4	2	1	0	0	0	50

表 3-26 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																												
February	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15 - 16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3

表 3-27 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																															
March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	31
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17 - 18	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
18 - 19	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	9
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	3	0	0	3	0	0	0	0	0	0	0	4	29	1	0	0	0	0	0	0	0	0	0	0	0	0	0	13	2	9	8	72

表 3-28 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																														
April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 - 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

表 3-29 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																															
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		2
10 - 11	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		2
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	2	52	0	0	0	0	0	0		59
13 - 14	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	0	0	8	2	0	0	0	0	0	0		15
14 - 15	0	0	0	0	0	0	0	0	0	6	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1		9
15 - 16	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		4
16 - 17	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		4
17 - 18	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
18 - 19	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		2
19 - 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0		2
20 - 21	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0		40
21 - 22	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		5
22 - 23	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
23 - 24	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0		8
00 - 01	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		2
01 - 02	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0		5
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
* DAILY	0	0	0	0	0	0	0	0	0	9	12	14	5	0	0	10	1	0	0	7	0	0	11	54	0	0	40	0	0	1	0	164

表 3-30 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																														
June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	**TOTAL**
08 - 09	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	0	12
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	3	0	0	0	0	0	13
15 - 16	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	26	0	0	0	0	0	0	5	0	1	0	0	2	0	0	38
16 - 17	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8	0	0	0	0	0	0	0	31
17 - 18	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
18 - 19	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	14
19 - 20	0	0	36	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	69
20 - 21	0	0	20	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
21 - 22	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4
22 - 23	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	6
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
02 - 03	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	0	69	61	0	0	0	0	0	0	1	36	0	37	3	24	27	1	0	0	0	10	0	13	11	12	0	6	5	0	1	317

表 3-31 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																															
July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	5	13
09 - 10	0	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	1	13
10 - 11	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	22	5	1	0	0	0	0	0	0	33
11 - 12	0	0	0	1	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	4	7	0	0	0	0	0	0	1	17
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	2	1	1	0	0	0	0	1	1	11
13 - 14	0	0	0	0	0	4	0	2	0	0	0	3	1	0	0	0	0	0	0	0	0	0	4	1	7	0	0	0	4	2	6	34
14 - 15	0	0	0	0	0	0	0	1	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	5	34	0	0	0	51	3	1	102
15 - 16	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	2	8	4	15	0	0	0	3	4	0	56
16 - 17	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	14	0	3	4	0	0	0	2	1	30
17 - 18	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	14	0	5	0	0	0	0	1	0	0
18 - 19	0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	5	12	0	2	1	0	1	0	0	0	28
19 - 20	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	8	5	1	0	2	0	0	0	21
20 - 21	0	0	0	0	0	2	0	1	0	0	0	1	3	0	0	0	0	0	0	0	0	0	1	3	1	0	0	3	0	0	0	15
21 - 22	0	0	0	0	0	4	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	2	6	1	0	0	1	0	0	2	22
22 - 23	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11	0	1	0	0	3	0	0	19
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	2	0	20	0	0	12	0	0	39
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	3	0	2	0	0	6	0	1	17
01 - 02	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	5	0	1	0	0	0	0	0	10
02 - 03	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	10
03 - 04	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	12	7	3	0	0	0	0	4	0	0	29
04 - 05	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	5	4	14	0	0	0	0	1	0	0	27
05 - 06	0	0	0	0	0	0	0	0	0	0	4	0	9	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	15
06 - 07	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	4	3	0	0	1	0	0	1	2	1	26
07 - 08	0	0	0	0	0	0	0	0	1	0	6	0	7	0	0	0	0	0	0	0	1	6	2	15	0	0	0	0	0	4	0	42
* DAILY	0	0	0	3	0	20	0	10	1	0	58	13	40	14	0	0	1	4	1	0	1	40	108	101	76	31	0	7	85	19	20	653

表 3-32 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																															
August	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	3	0	0	2	0	1	0	0	0	0	0	0	0	1	0	0							7
09 - 10	0	0	0	0	0	0	0	1	1	0	0	0	1	3	2	0	0	0	0	0	0	0	0	0	0							8
10 - 11	0	0	0	14	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	2	0	0							19
11 - 12	1	0	0	2	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0							8
12 - 13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0							5
13 - 14	0	0	0	0	0	0	0	1	0	2	0	0	0	0	1	3	0	1	0	0	0	0	0	0	0							8
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	1	2	0	1							9
15 - 16	0	0	0	0	0	0	0	0	0	0	0	14	1	8	0	0	0	0	0	0	0	0	1	0	0				0	0		24
16 - 17	0	0	0	0	1	0	0	0	0	0	0	20	0	1	0	0	0	0	0	0	0	0	0	0	1				0	0		23
17 - 18	1	0	0	0	2	9	0	0	0	0	8	4	0	1	0	0	0	0	0	0	0	0	0	0	0				0	0	6	31
18 - 19	0	0	0	0	1	3	0	1	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0		32
19 - 20	0	0	0	0	1	1	1	1	0	0	26	0	0	0	0	0	0	0	0	1	3	7	1	0	0				0	0		42
20 - 21	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	1	1	0	5	0	2	0	0	0				0	0		16
21 - 22	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	1	0	2	0	0	0	0	0				0	0		6
22 - 23	0	0	0	0	2	0	0	0	0	0	0	0	9	0	0	0	0	0	0	1	0	0	0	0	0				0	0		12
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	2	0	0	0	0	0				0	0		7
00 - 01	0	0	0	0	0	0	2	0	0	0	1	0	9	0	0	0	0	1	0	1	0	0	0	0	0							14
01 - 02	0	0	0	0	0	0	1	1	0	0	0	2	6	0	0	0	1	5	0	0	0	0	0	0	0							16
02 - 03	0	0	0	0	0	0	0	2	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0							6
03 - 04	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0							6
04 - 05	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	0	0	0	0							10
05 - 06	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							1
06 - 07	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0							3
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0							1
* DAILY	2	0	0	16	11	18	4	8	1	9	71	42	33	21	7	7	7	9	3	15	4	11	7	0	2	0	0	0	0	0	6	314

表 3-33 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																														
September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	27	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	29
09 - 10	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	17
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	8	0	0	14
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	3	18	0	0	26
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	16	1	8	0	0	26
15 - 16	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	1	0	3	1	0	0	14
16 - 17	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	8	0	0	0	0	5	0	7	4	0	0	31
17 - 18	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	3	1	0	0	0
18 - 19	0	0	3	11	0	0	1	0	0	0	0	0	0	0	0	0	1	32	0	10	0	0	0	0	0	1	0	0	0	0	59
19 - 20	0	0	1	0	0	0	1	59	48	0	0	0	0	0	0	0	0	1	0	2	0	0	0	4	0	14	0	0	0	0	130
20 - 21	0	0	0	0	0	0	0	1	86	0	0	0	0	0	0	0	0	0	3	1	0	0	0	5	0	0	0	0	0	0	96
21 - 22	0	0	0	0	6	0	0	0	14	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	24
22 - 23	0	0	0	1	19	0	0	0	3	1	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	1	0	0	0	29
23 - 24	0	0	0	1	4	0	0	0	4	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	13
00 - 01	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3
01 - 02	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	13
02 - 03	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	2	0	0	0	29
03 - 04	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	11
04 - 05	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	4
05 - 06	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	10
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	16
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
* DAILY	0	0	4	20	33	43	6	60	156	27	1	0	0	0	0	0	5	35	6	21	0	14	5	37	11	31	52	43	0	0	610

表 3-34 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																															
October	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	6
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	7
13 - 14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14 - 15	0	0	0	1	0	0	0	0	1	0	0	3	24	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	32
15 - 16	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	8	0	0	0	0	0	0	0	2	0	0	0	0	0	0	12
16 - 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
17 - 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 - 19	0	0	0	0	0	0	0	0	15	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
19 - 20	0	0	0	0	0	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	10
20 - 21	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	19
21 - 22	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22 - 23	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6
* DAILY	0	0	0	9	19	0	0	0	23	1	2	5	25	0	0	0	14	0	0	0	0	0	0	0	11	0	1	0	34	17	0	161

表 3-35 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																														
November	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 - 13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13 - 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
14 - 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15 - 16	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	6
16 - 17	0	0	1	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
17 - 18	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
18 - 19	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
19 - 20	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
20 - 21	8	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
21 - 22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22 - 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 - 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11
00 - 01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
01 - 02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	16
03 - 04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04 - 05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
05 - 06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06 - 07	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07 - 08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
* DAILY	18	0	1	4	1	17	0	2	0	1	0	0	0	0	0	1	0	0	6	0	0	0	0	0	0	0	0	0	0	35	86

表 3-36 Hourly Rainfall at Science Garden in 2006

Unit : mm

2006																															
December	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
08 - 09	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
09 - 10	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10 - 11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11 - 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
12 - 13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	8
13 - 14	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
14 - 15	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
15 - 16	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16 - 17	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
17 - 18	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
18 - 19	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
19 - 20	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20 - 21	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
21 - 22	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
22 - 23	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
23 - 24	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
00 - 01	0	0	0	0	0	0	1	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
01 - 02	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
02 - 03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03 - 04	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
04 - 05	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05 - 06	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
06 - 07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 - 08	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
* DAILY	0	0	0	0	0	0	2	0	3	46	4	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	64

表 4-1 Annual Maximum Rainfall at Science Garden Station

Unit: mm

Year	1 hour	2-hour	3-hour	6-hour	12-hour	24-hour	48-hour
1961	-	-	-	177.8	213.1	251.0	280.2
1962	-	-	-	135.6	173.7	205.0	327.9
1963	-	-	-	71.6	125.0	167.1	178.3
1964	-	-	-	99.1	104.1	198.3	259.5
1965	50.8	73.3	88.2	115.3	140.8	159.8	239.3
1966	60.0	85.1	100.7	125.1	153.9	169.9	274.3
1967	102.4	149.6	181.0	239.7	292.8	334.5	350.0
1968	45.6	66.1	79.6	104.7	127.9	145.5	205.0
1969	38.9	56.4	67.8	88.4	108.6	122.8	397.3
1970	83.7	122.4	148.4	197.7	241.0	276.5	-
1971	46.2	54.7	57.9	74.4	80.5	84.6	103.7
1972	72.5	122.5	143.5	158.5	159.8	218.0	435.2
1973	130.3	130.8	131.3	131.3	131.3	131.3	298.1
1974	42.2	77.5	102.6	149.4	180.8	214.3	366.3
1975	31.7	48.9	68.0	104.9	170.1	209.3	247.7
1976	128.0	186.3	224.7	294.5	361.2	410.1	-
1977	39.3	58.5	71.5	90.3	116.3	135.7	-
1978	47.2	68.1	81.3	103.8	148.2	174.4	255.5
1979	67.1	86.9	130.3	179.3	191.7	223.0	297.9
1980	46.0	70.4	77.4	102.7	123.6	133.8	147.5
1981	37.5	50.0	52.4	73.0	115.7	161.0	230.9
1982	42.2	60.1	71.2	89.1	109.8	121.6	144.2
1983	35.2	51.3	62.0	82.0	100.2	114.4	131.2
1984	35.4	50.9	60.8	77.4	95.4	106.6	-
1985	41.8	60.3	72.6	95.1	116.0	131.0	-
1986	72.2	122.7	150.7	176.1	184.9	190.4	367.5
1987	42.4	62.0	74.7	99.0	120.1	137.6	142.0
1988	38.5	55.6	67.2	88.9	107.7	123.1	240.5
1989	32.4	45.8	54.5	70.4	85.2	96.4	175.4
1990	63.7	91.9	110.4	143.8	176.0	199.4	233.6
1991	-	-	-	157.8	194.2	253.5	295.5
1992	-	-	-	81.2	101.0	145.2	177.6
1993	-	-	-	112.6	138.6	151.9	209.4
1994	-	-	-	106.6	145.8	169.8	196.4
1995	-	-	-	72.0	106.0	163.6	169.8
1996	-	-	-	81.2	94.2	120.2	155.0
1997	-	-	-	104.2	191.8	223.8	301.2
1998	-	-	-	89.8	108.7	172.7	241.5
1999	-	-	-	191.7	204.8	280.7	431.3
2000	-	-	-	181.4	260.2	267.0	319.2
2001	-	-	-	88.0	105.0	129.4	209.7
2002	-	-	-	80.6	152.4	216.3	417.9
2003	-	-	-	73.2	99.0	156.0	278.6
2004	49.0	82.0	106.0	172.0	201.0	230.0	312.0
2005	39.0	65.0	74.0	82.0	83.0	100.0	119.0
2006	86.0	134.0	148.0	155.0	156.0	156.0	226.0

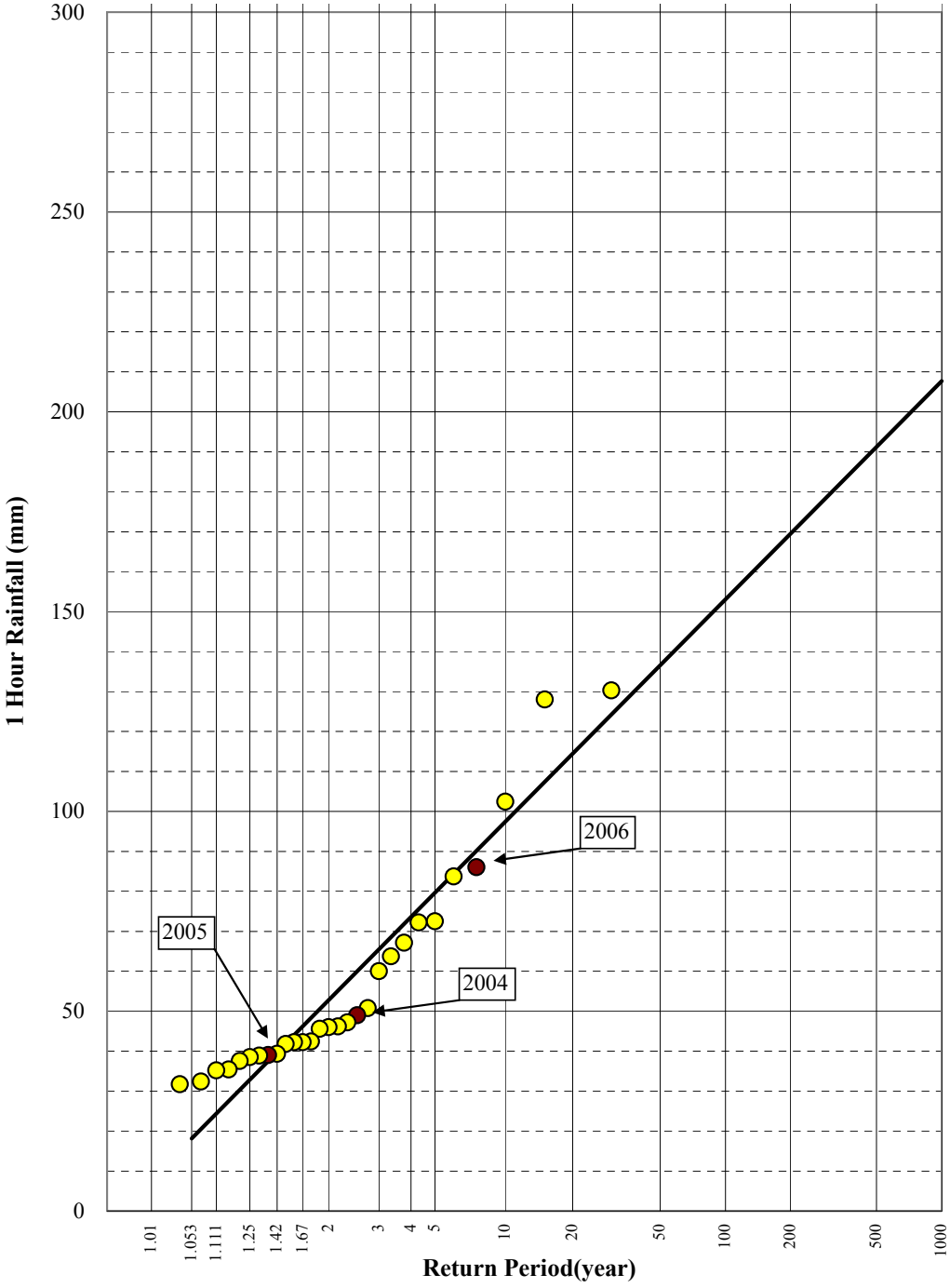


図 6-1 Probability Analysis of 1-Hour Rainfall at Science Garden

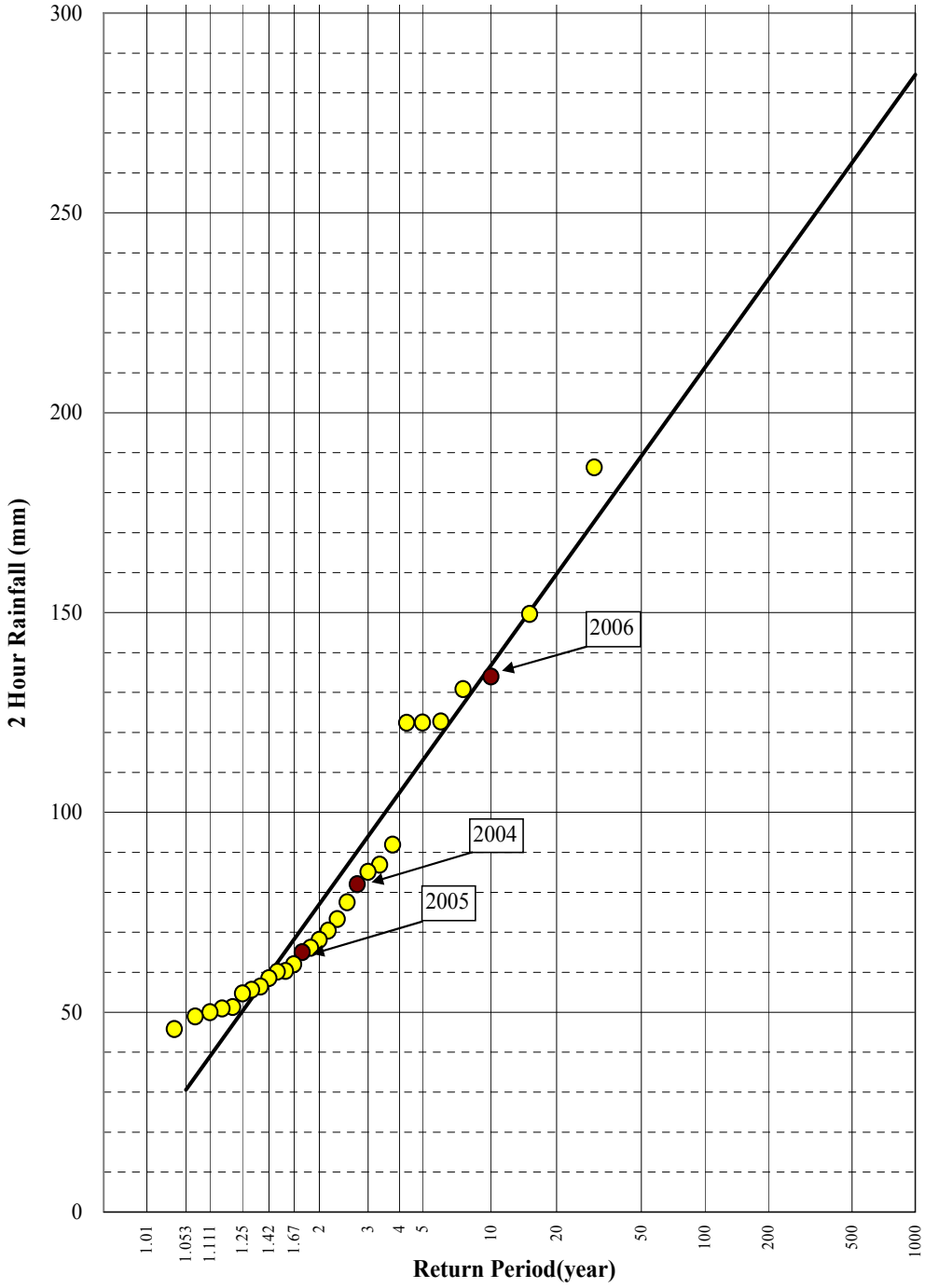


図 6-2 Probability Analysis of 2-Hour Rainfall at Science Garden

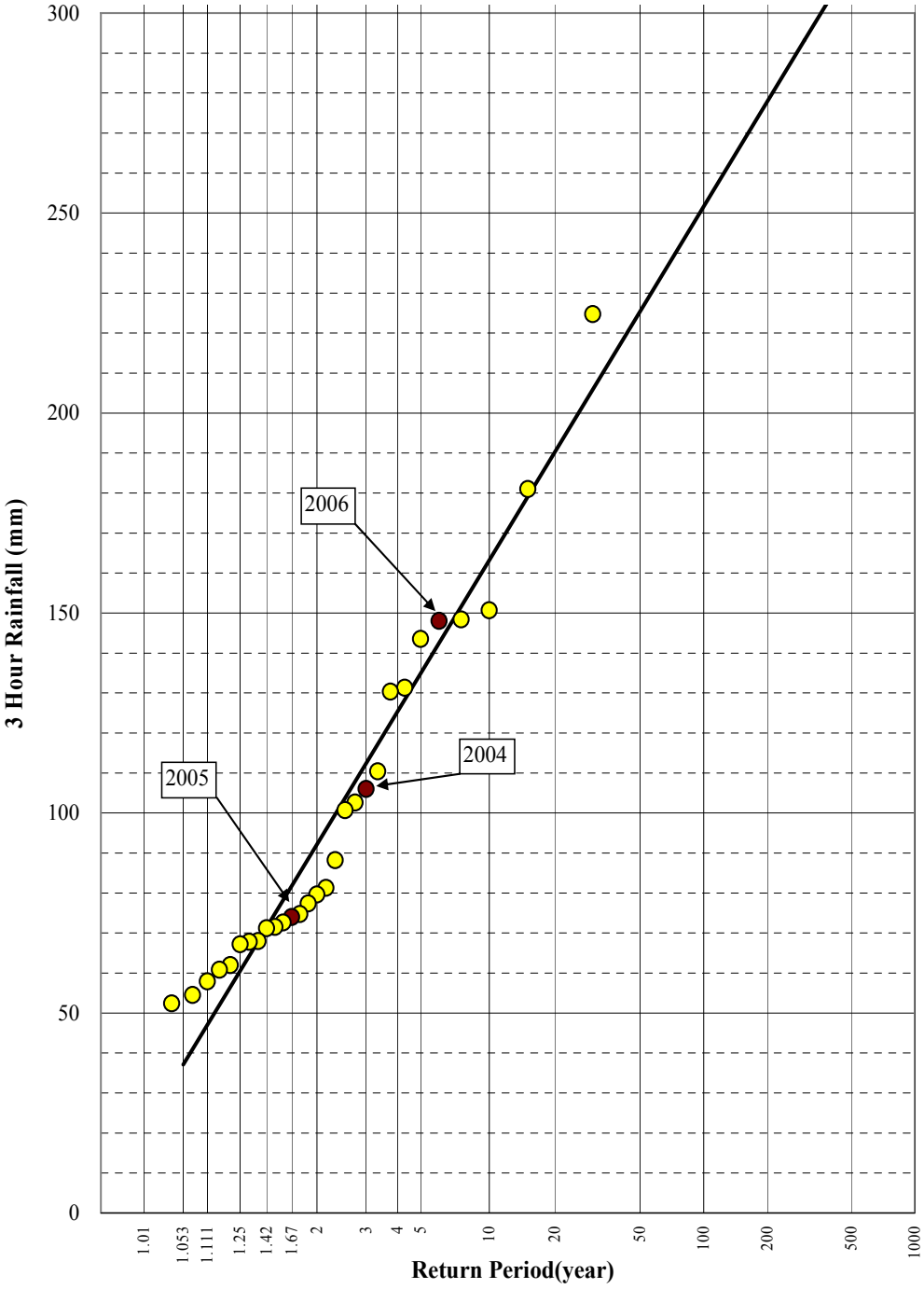


図 6-3 Probability Analysis of 3-Hour Rainfall at Science Garden

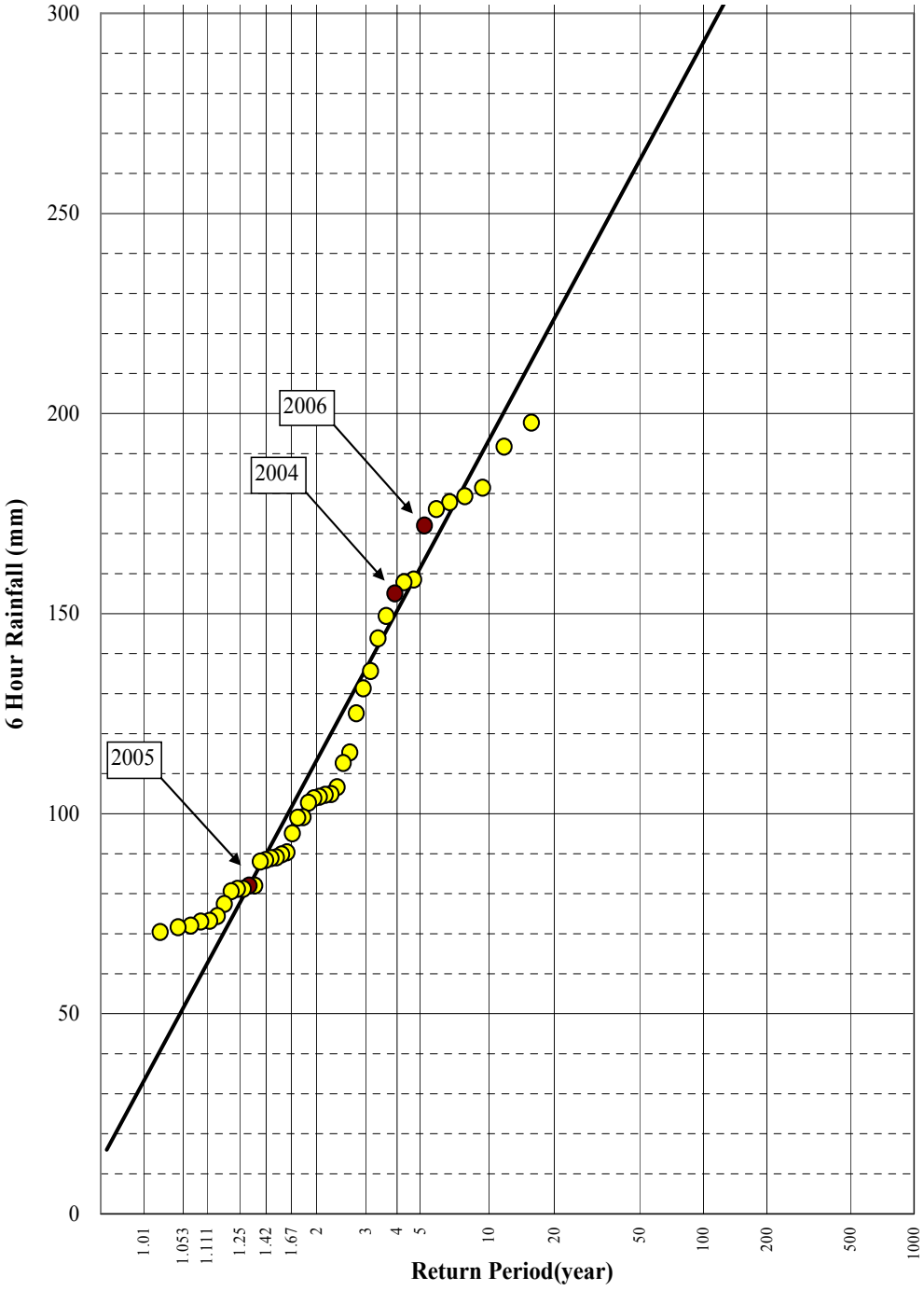


図 6-4 Probability Analysis of 6-Hour Rainfall at Science Garden

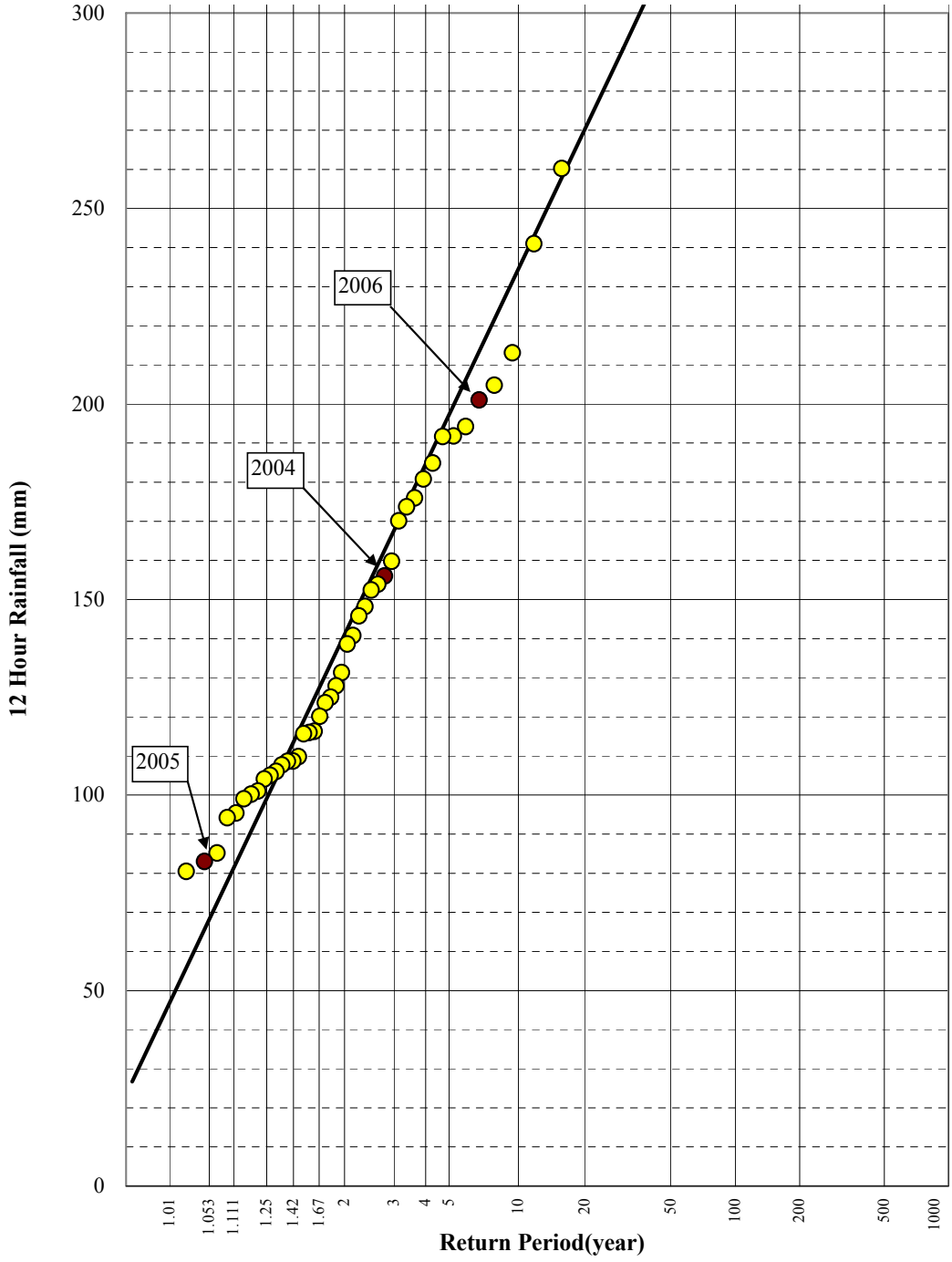


図 6-5 Probability Analysis of 12-Hour Rainfall at Science Garden

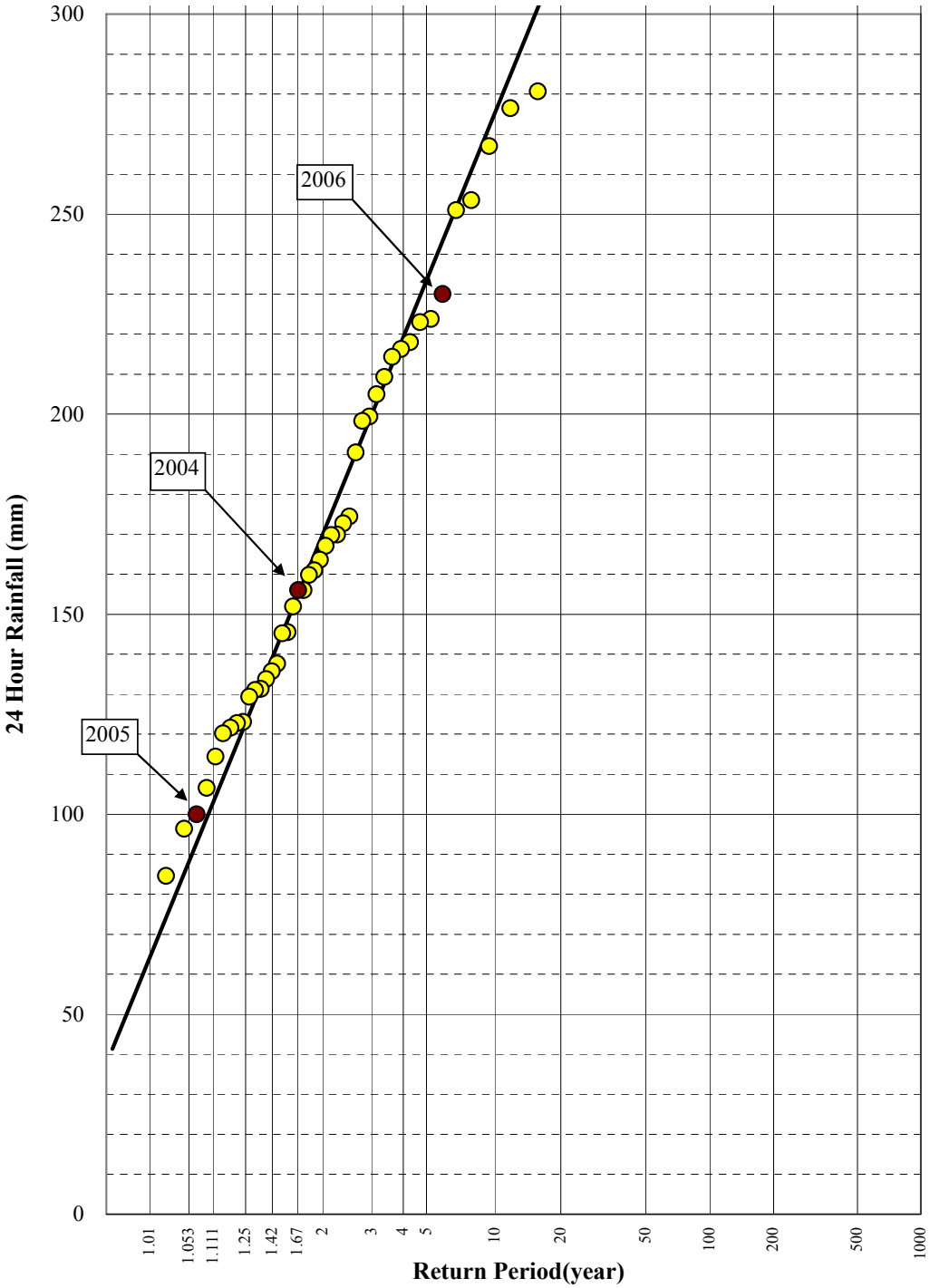


図 6-6 Probability Analysis of 24-Hour Rainfall at Science Garden

C　　排水路の現状

C　排水路の現況

1.　概　要

本基本設計調査における対象排水機場は、キアポ(Quiapo)、アビレス・サンパロック(Aviles・Sampaloc)、トリパ・デ・ガリナ(Tripa de Gallina)の 3 排水機場である。これらの位置は図 1-1 に示すとおりである。また、主要排水路位置は図 1-2 に示す。

2.　現　況

2.1　キアポ排水機場排水路

キアポ排水機場への流入水路の水面は、写真に示すとおり、ごみと浮き草（ホテイアオイ）に埋め尽くされている状況である。

キアポ排水機場流入水路　（2007 年 3 月 3 日）

排水路両側には、写真に見られるように、ぎっしりと人家が密集しているが、排水路内に人家が入り込んでいるわけではない。一部は水路上に張り出しているものもあるが、特に流水の障害になってはいない。また、水路幅は、後の詳細な検討が必要であるが、ポンプ場の規模に見合った幅が確保されていると見られる。

排水機場の下流側は、写真に見られるように殆どごみは見られないし、不法住宅も入り込んではいない。

キアポ排水機場下流側水路　（2007 年 3 月 3 日）

主要排水路の一つは Estero de San Miguel であり、アビレス・サンパロック排水機場とつながっている水路である。このエステロは以下の写真に示すような水路である。

Estero de San Miguel　（2007 年 3 月 8 日）

ここも、若干ごみが堆積しているようであるが、特に不法住宅が占拠しているわけではない。もう一つの主要排水路は Estero de Quiapo であるが、こちらのエステロは以下の写真に示すような状況である。

Estero de Quiapo　（2007 年 3 月 8 日）

写真に見られるように、エステロ内にかなり不法住宅が張り出しており、これらの住宅は水路内に多くの基礎杭を有しているようであり、その状況によっては、流水の阻害につながる可能性もある。また排水路内のごみの量もかなり多い。しかし、計画排水量から見ると、水路幅そのものは充分にあると見られる。

このエステロに流れ込む二次排水路のひとつは、開発調査で NE13 と称され、以下の写真に示すような状況である。

Estero de Quiapo　二次排水路　(2007 年 3 月 8 日)

一方、Estero de Sam Miguel に流入する二次排水路のうち、開発調査で NE15 と称される水路は、以下の写真に示す状況となっている。

Estero de San Miguel　二次排水路　（2007 年 3 月 8 日）

写真に見られるように、完全に埋め尽くされ、排水路としての機能は完全に失われている状況である。このため、付近の住民の話では、毎年道路が排水路となり、年によっては腰や膝のあたりまでの水深となる、とのことである。

2.2　アビレス・サンパロック排水機場

アビレス・サンパロック排水機場流入水路　（2007 年 3 月 3 日）

アビレス・サンパロック排水機場に流入する水路は、写真に見られるように、ごみもなく、不法住宅もなく、建設当初の形をそのまま残していると思われる状況である。

アビレス・サンパロック排水機場の主要排水路は Estero de Sampaloc であり、J.P. Laurel 道路との交差地点では、以下の写真に示す状況となっている。

Estero de Sampaloc　（2007 年 3 月 8 日）

写真に見られるように、ごみもなく、不法住宅もなく、特に問題はない水路である。

一方、この水路の上流に位置し、開発調査で NE18 と称された排水路は、以下に示す写真のような状況となっている。

Estero de Sampaloc　（2007 年 3 月 8 日）

写真に見られるように、道路下の暗渠に入る区間でごみが集積している状況となっている。

しかし、その上流部では、下の写真に示すように、それほどごみが集積した状況ではないが、不法住宅が一部排水路内に入り込んでいる。

2.3　　トリパ・デ・ガリナ排水機場

トリパ・デ・ガリナ排水機場流入水路　（2007 年 3 月 3 日）

写真に見られるように、排水機場直上流での水路内にはごみの集積は見られないが、機場には、次の写真に見られるように、ごみが集積している。

本排水機場の下流の水路は、Parañaque River である。これより上流は、Estero de Tripa de Gallina である。

この排水機場の上流約 500ｍの位置に小さな貯水池が設けられており、ここでは以下の写真に示すとおり、周辺には多くの不法住宅と見られる人家が密集している。しかし、ごみは貯水池内に大きく広がって集積しているわけではない。

Estero de Tripa de Gallina 貯水池　（2007 年 3 月 9 日）

なお、Estero de Tripa de Gallina は、遠く Pasig River につながる排水ブロックにまで至っているが、ほぼ 3.0 km 上流の Antonio S Aranaiz Avenue と交錯する地点で、Libertad 排水機場との流域界となっていると見られる。なお、ここでの排水路現況は以下に示す写真のような状況となっている。

Estero de Tripa de Gallina at Antonio S Aranaiz Avenue　（2007 年 3 月 9 日）

写真に見られるように、水路幅はほぼ確保されているが、人家が水路上に張り出しており、また、ごみがかなりたまっている状況にある。

また、ここより少し東方でエステロに流入する二次排水路である Zanzibar Creek は、以下に示す写真のような状況にある。

Zainzibar Creek　　（2007 年 3 月 9 日）

ここにおいては、不法占拠は見当たらないが、かなりのごみが堆積している。また、この写真に示される道路の上には高速道路が走っており、その橋脚がこの排水路を完全に塞ぐ形で建設されており、この排水路もその機能が完全に失われている。

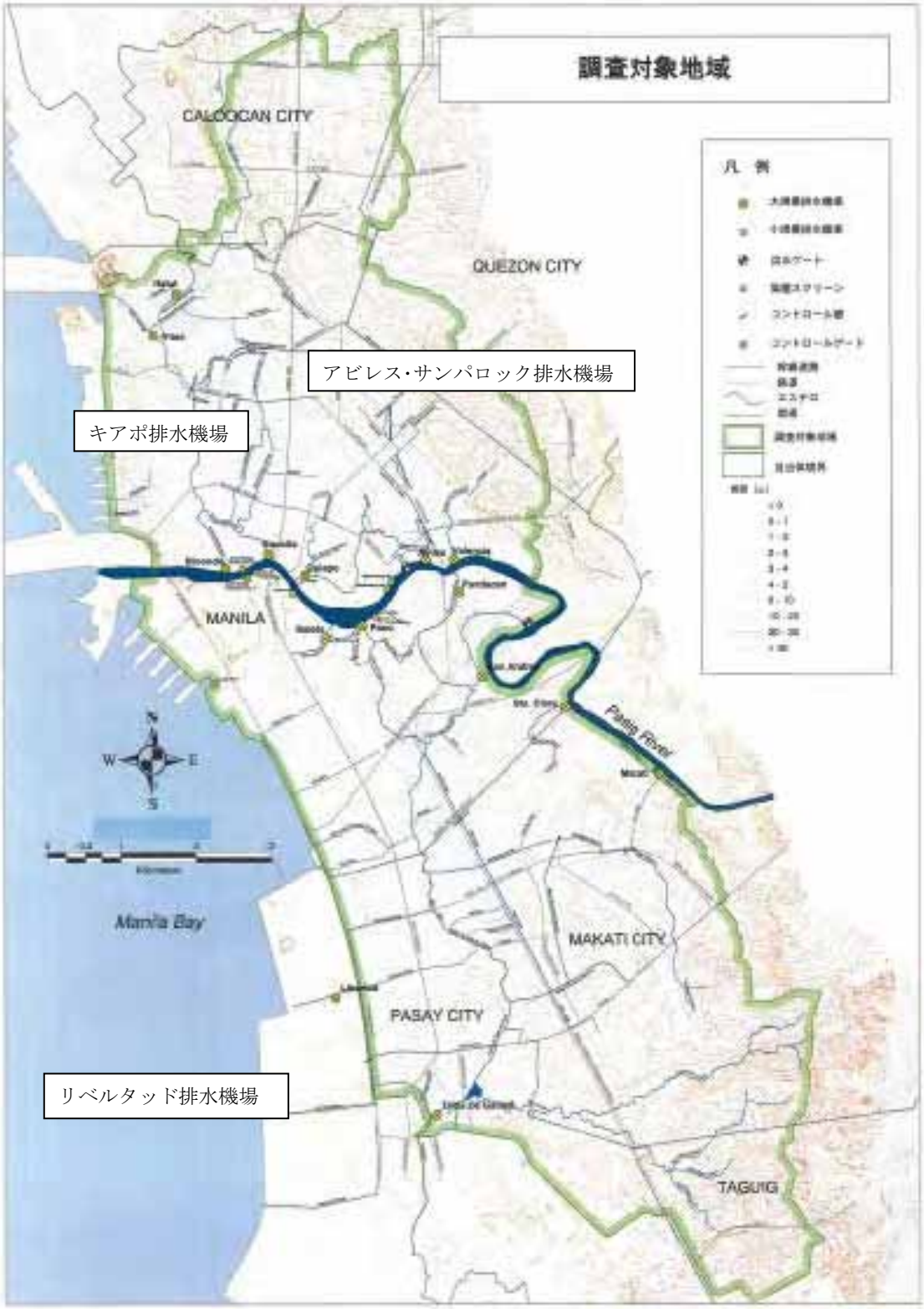

調査対象地域
CALOOCAN CITY
QUEZON CITY
MANILA
MAKATI CITY
PASAY CITY
TAGUIG
Manila Bay
Pasig River
凡 例
アビレス・サンパロック排水機場
キアポ排水機場
リベルタッド排水機場

図　1-1　排水機場位置図

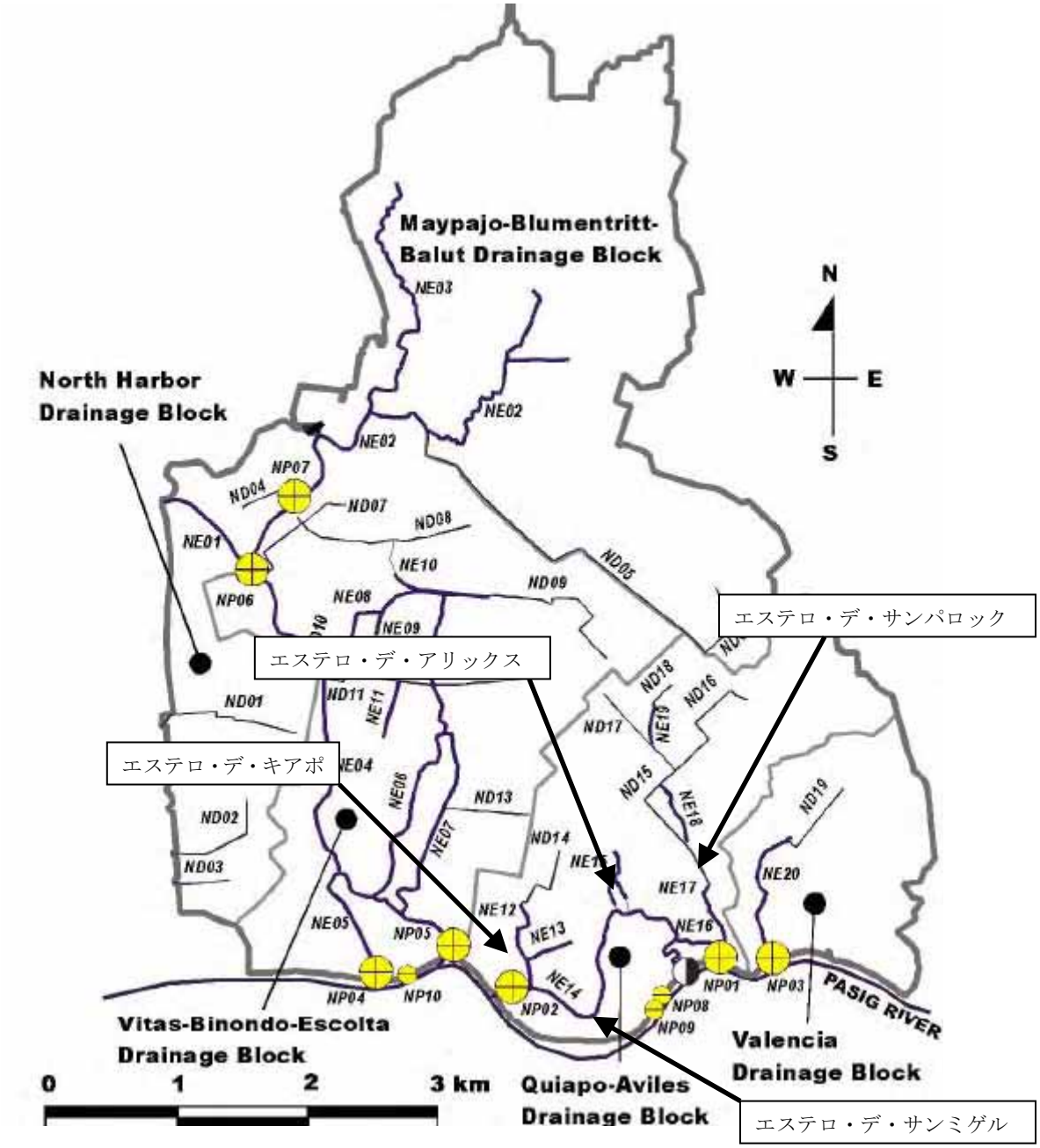


図　1-2（1）　キアポーアビレス･サンパロック排水ブロック主要排水路位置

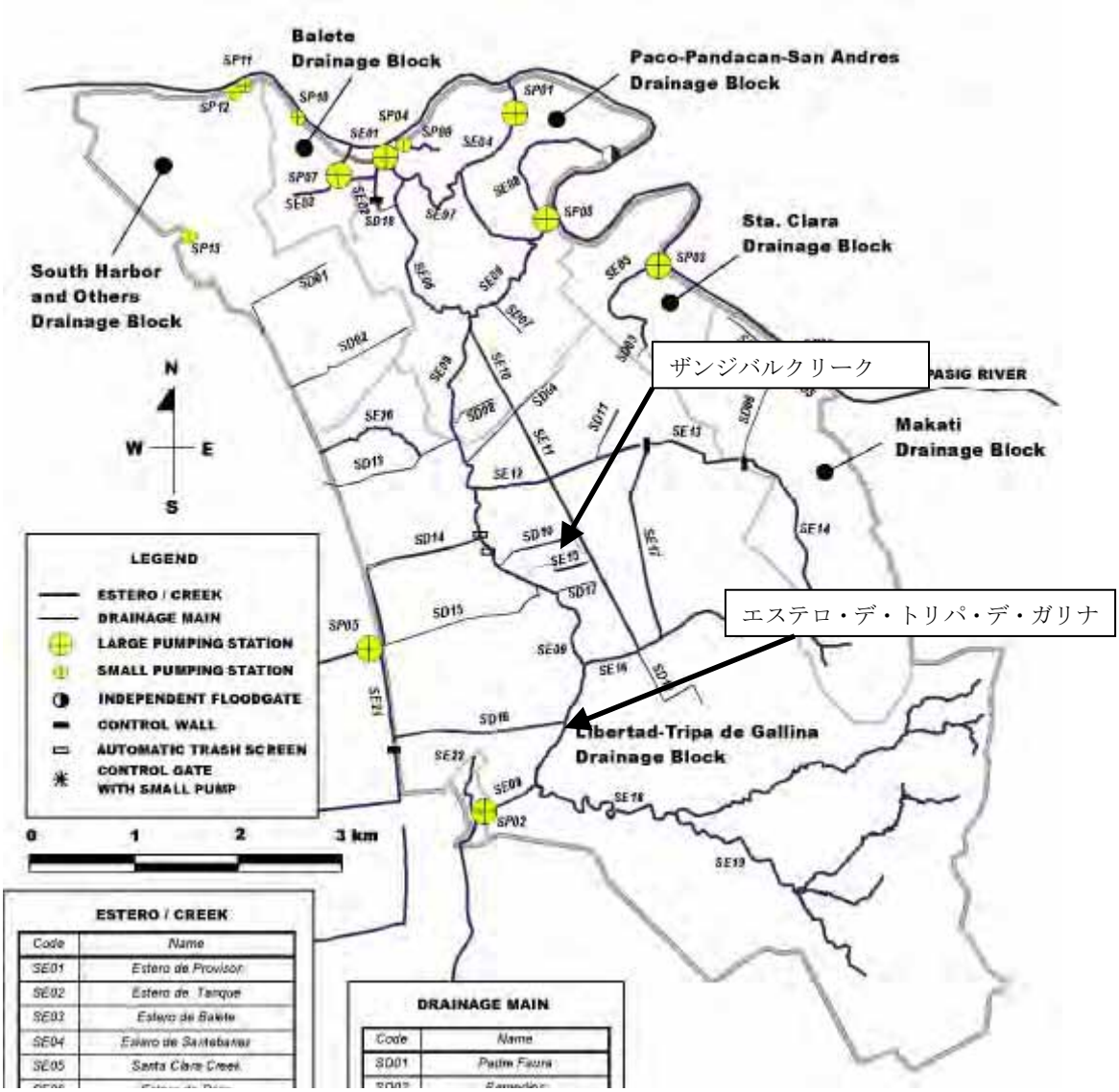


図　1-2（2）　トリパ・デ・ガリナ排水ブロック　主要排水路位置

D　　排水路流下能力の検討

D　排水路流下能力の検討

1.　排水路横断比較

1.1　概　要

2004 年から 2005 年にかけて行われた「マニラ首都圏中心地域排水機能向上調査」により、排水路横断測量が一部の箇所で行われている。この横断測量が行われた地点において、今回、簡易横断測量を行い、2004 年と 2007 年で排水路の流積の変化を評価した。測量予定地点は以下のようであった。

排水ブロック	排水路名	箇所数
キアポ	Estero de Alix	2 箇所
アビレス・サンパロック	Estero de Sampaloc	2 箇所
トリパ・デ・ガリナ	Estero de Tripa de Gallina	8 箇所
“do“	Zanzibar Creek	2 箇所

しかし、現場に赴いたところ、現在、水路としての機能を果たしていない箇所や、フェンスが張られて立ち入り不可能な場所等があり、測量箇所は以下のように変更を行った。

排水ブロック	排水路名	箇所数
キアポ	Estero de San Miguel, etc.	2 箇所
アビレス・サンパロック	Estero de Sampaloc	4 箇所
トリパ・デ・ガリナ	Estero de Tripa de Gallina	8 箇所

また、限られた日数内での測量であることと、一部のベンチマークは失われていることを考慮して、各横断地点での測量とし、絶対標高との関連付けは行わず、開発調査の測量との橋台部分標高の調整で、比較を行うこととした。

1.2　測量結果と横断比較

実際の測量実施箇所の位置は、図 1.2.1 に示す。また、測量結果の横断図比較は図 1.2.2 に示すとおりである。

図 1.2.2 に示されるように、一部で前回に比べ、流積がかなり減少していると見受けられるところもあるが、概ね、開発調査時との断面変化は無視しできるものと判断できる。また、土砂の堆積による流積の減少と当初言われていたが、主要水路は市街地内を通過しており、主要な堆積物はごみであり、ここ数年でごみの堆積による断面変化は起きていない。

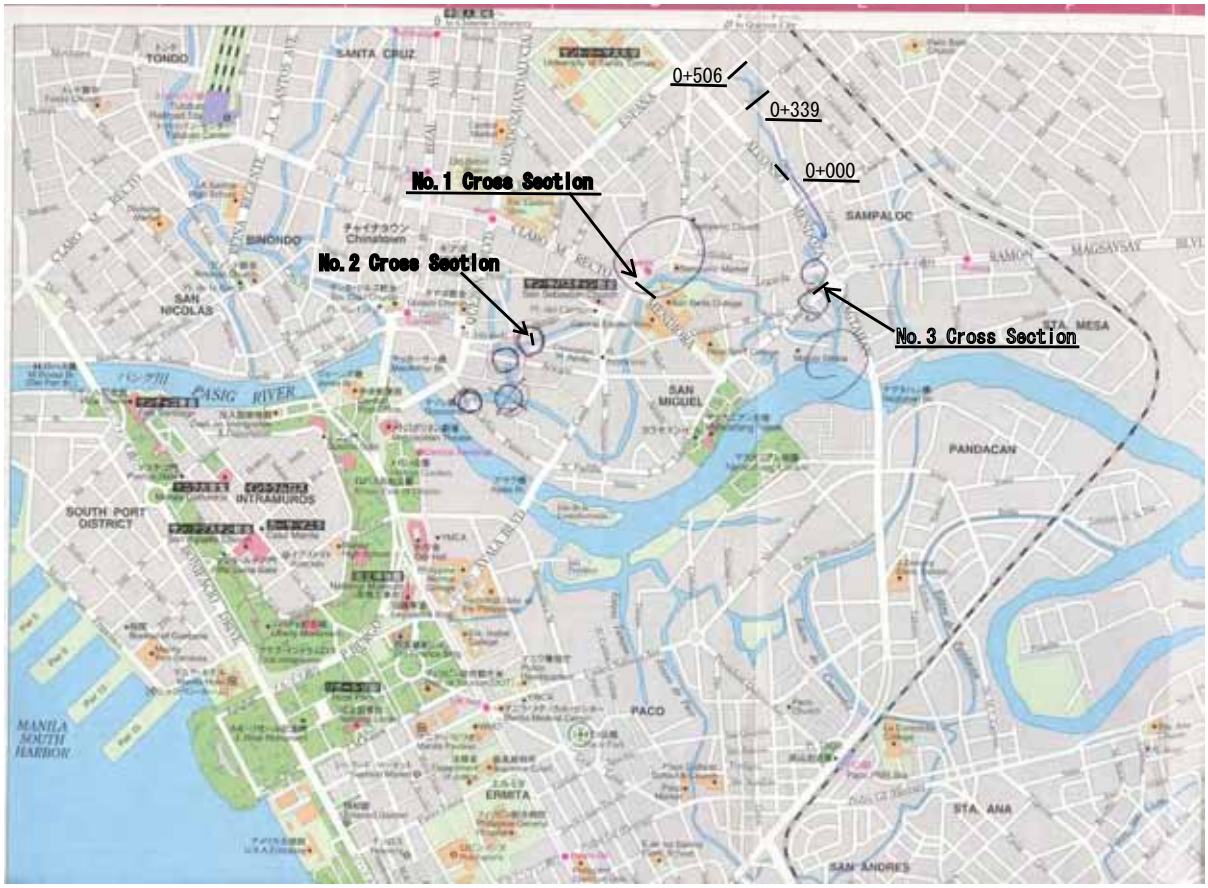


図 1.2.1（1）　キアポ・アビレス・サンパロック排水域　排水路横断測量測線位置

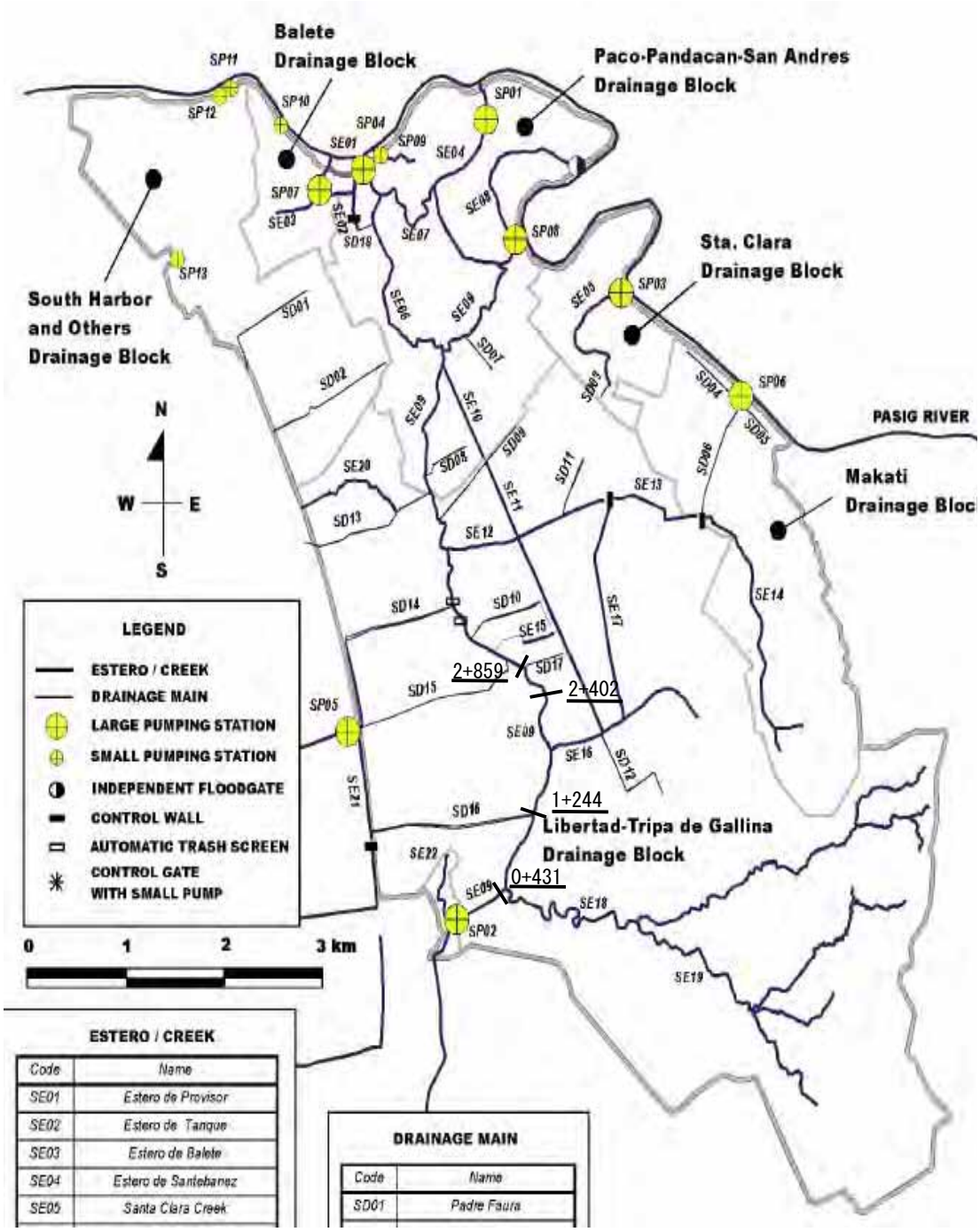
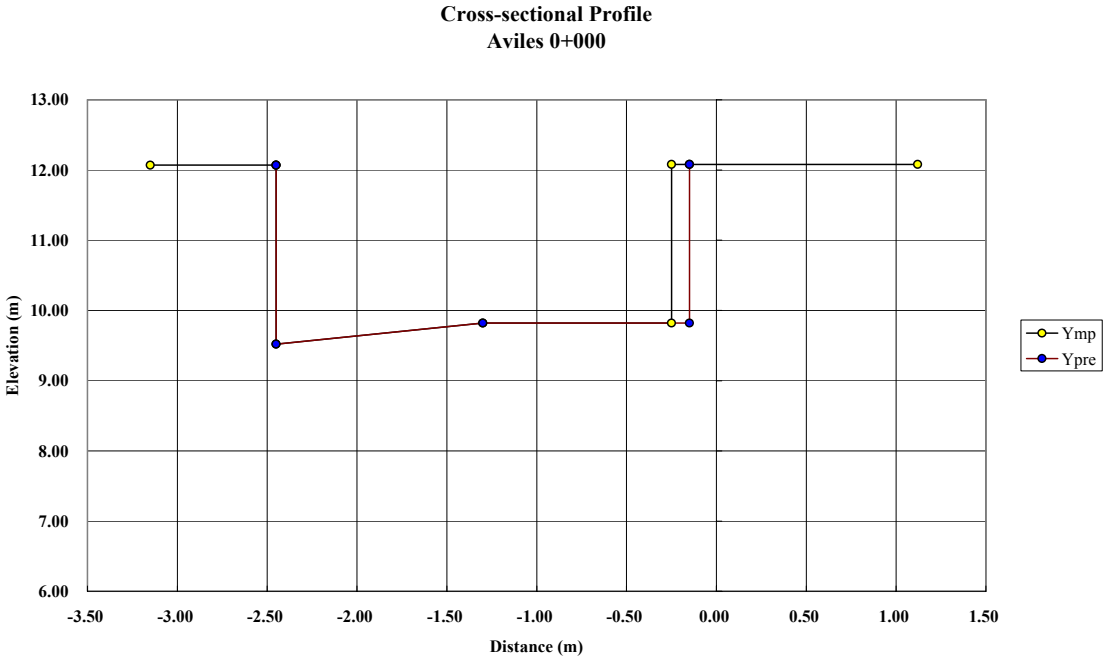
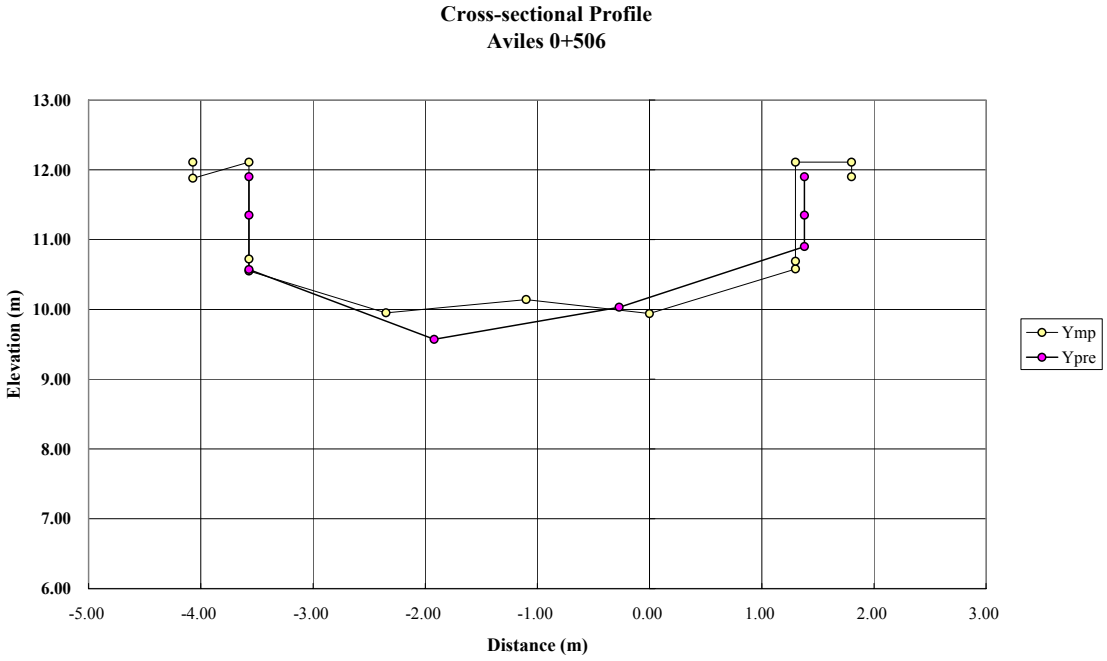


図 1.2.1（2）　トリパ・デ・ガリナ排水域排水路横断測量測線位置

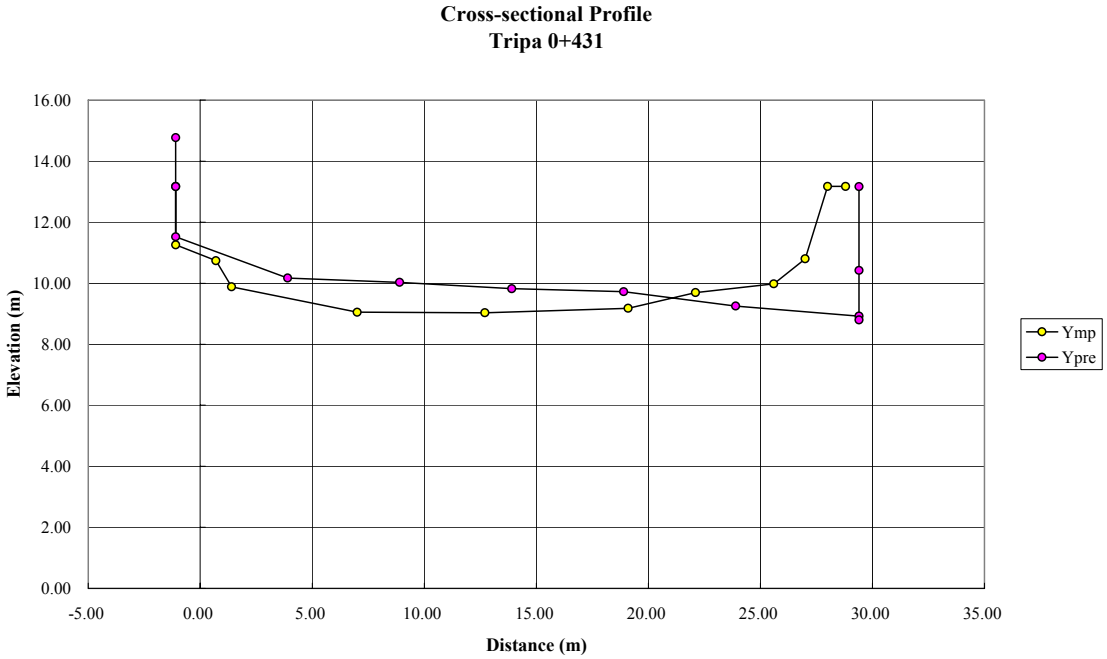


注）Ymp は開発調査時の断面を、Ypre は今回測量時断面を示す。

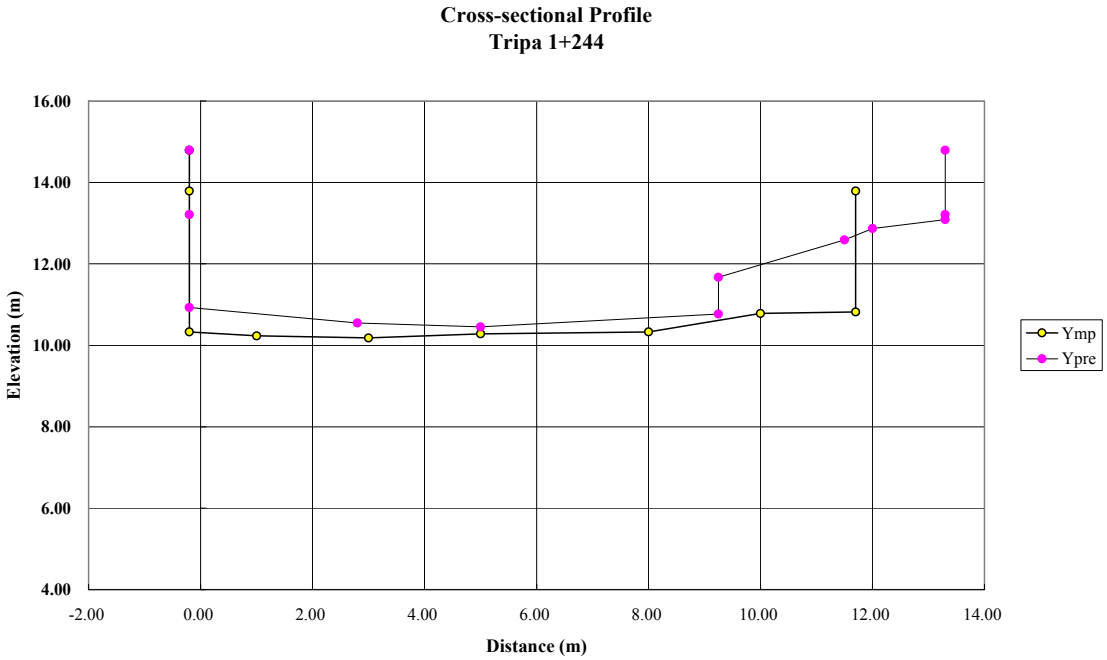


注）Ymp は開発調査時の断面を、Ypre は今回測量時断面を示す。

図 1.2.2（1）　排水路断面比較



注）Ymp は開発調査時の断面を、Ypre は今回測量時断面を示す。



注）Ymp は開発調査時の断面を、Ypre は今回測量時断面を示す。

図 1.2.2（2）　排水路断面比較

2. 排水路流下能力評価

2.1 概 要

2004 年から 2005 年にかけて行われたマニラ首都圏中心地域排水機能向上調査による排水路流下能力確率評価では、キアポの一部排水路を除いて、アビレス・サンパロック、トリパ・デ・ガリナ共に、その多くが 2 年確率以下の流下能力であると評価されている。これらの評価は、排水路の横断面が前項で述べたように、概ね変化がないことから、評価に変更はないことになる。

しかし、現地踏査で各排水機場、排水路を現場視察した結果によれば、排水機場の規模と排水路の規模は、それぞれ対応しており、ごみの集積は水面上では多いものの、排水路底面での堆積はそれほどでもないと判断できたので、以下に述べるような概略検討を行った。

2.2 評価手法

各排水機場流末での集水面積と各横断測線地点での集水面積は開発調査結果のものを利用し、各横断測線地点での想定流量として、排水機場での排水能力（10 年確率対応）から、流域面積比で算出したものを利用した。

これにより、各横断面がその想定流量を流すだけの能力を有しているかどうかを、一部は不等流計算により、一部は等流計算により判断し、各排水路が 10 年確率で計画され建設された排水機場の能力に見合った断面となっているかどうかを、評価した。

2.3 評価結果

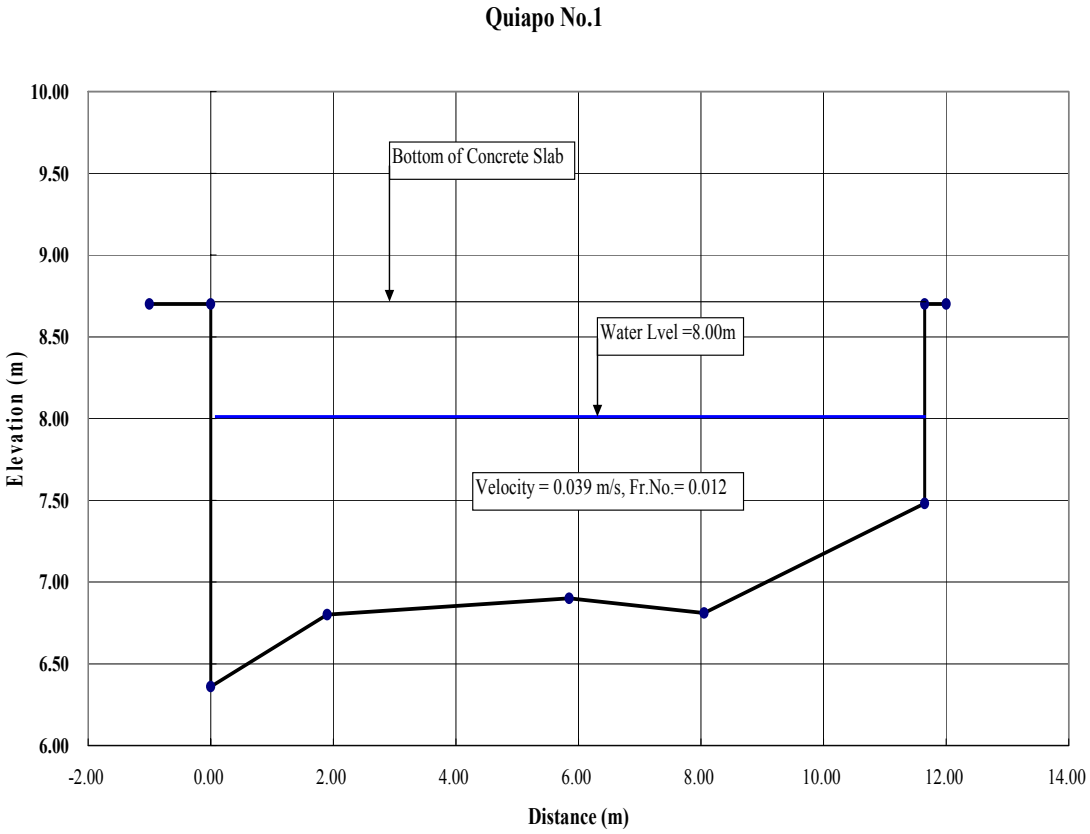
2.3.1 キアポ排水機場排水路

評価に利用した横断測線地点は、図 1.2.1(1)で示す No.1、No.2 地点である。No.1 地点は、Estero de San Miguel の Mendiora 橋付近の断面であり、No.2 地点は、Estero de Quiapo に流入する二次排水路の断面である。これらは、それぞれ、断面データも開発調査時のものが無いことから、等流計算も出来ないため、想定流量を流すに必要な流速と水深を求め、総合的な評価を行った。なお、Estero de Alix は前項で述べたように、完全に堰止められており、排水路としての機能は何もない。

① No.1 地点（Estero de San Miguel）

Section	Area (km^2)	Q10(m^3/s)	Remarks
Pumping Station	2.293	10.8	Design and Works
Q-No.1	0.100	0.5	Area Ratio Calculation

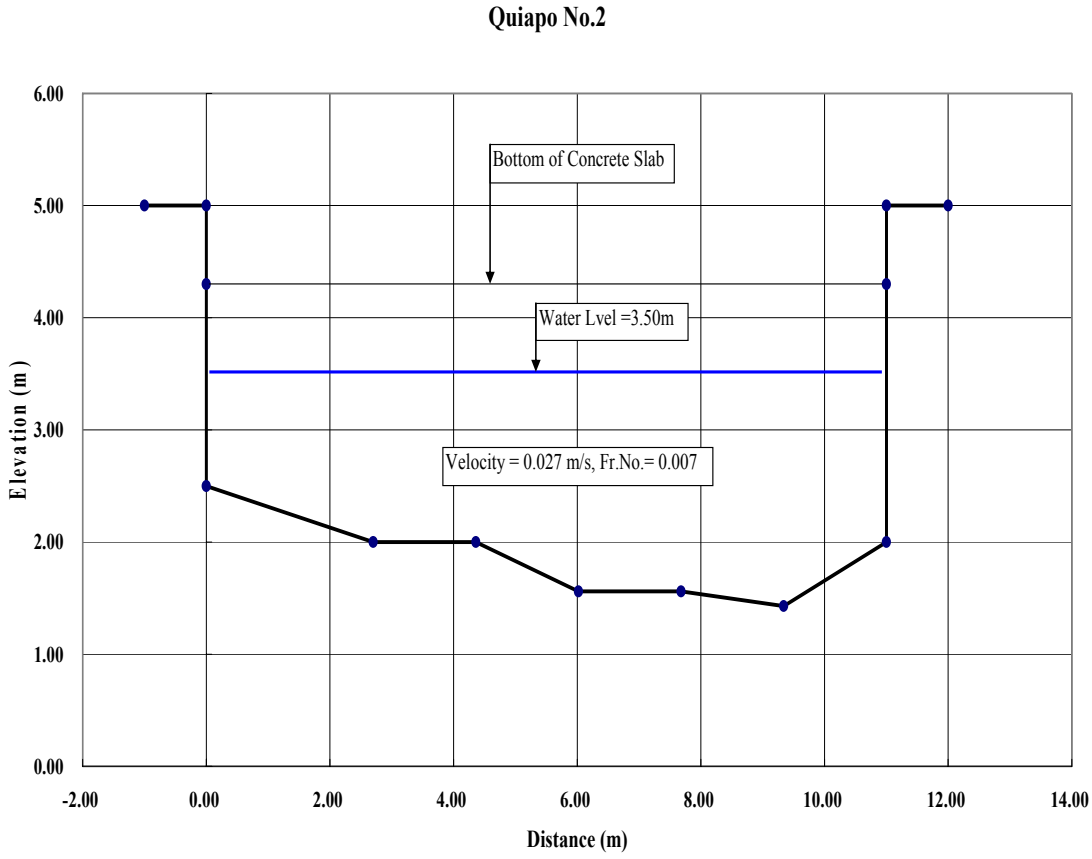
上記条件で水理計算を行ったところ、以下のような結果が得られた。



すなわち、橋台下のスラブの下高が 8.70ｍに対し、水面が 8.0ｍを想定しても、流速はわずか 0.039m/sec.であり、フルード数も 0.012 であり、これは、充分流下能力があるとの判断に立つことが可能であると判断される。したがって、Estero de San Miguel はキアポ排水機場排水能力に見合った流下能力があるといえる。

② No.2 地点（Estero de Quiapo への流入二次排水路）

Section	Area (km^2)	Q10(m^3/s)	Remarks
Pumping Station	2.293	10.8	Design and Works
Q-No.2	0.100	0.5	Area Ratio Calculation



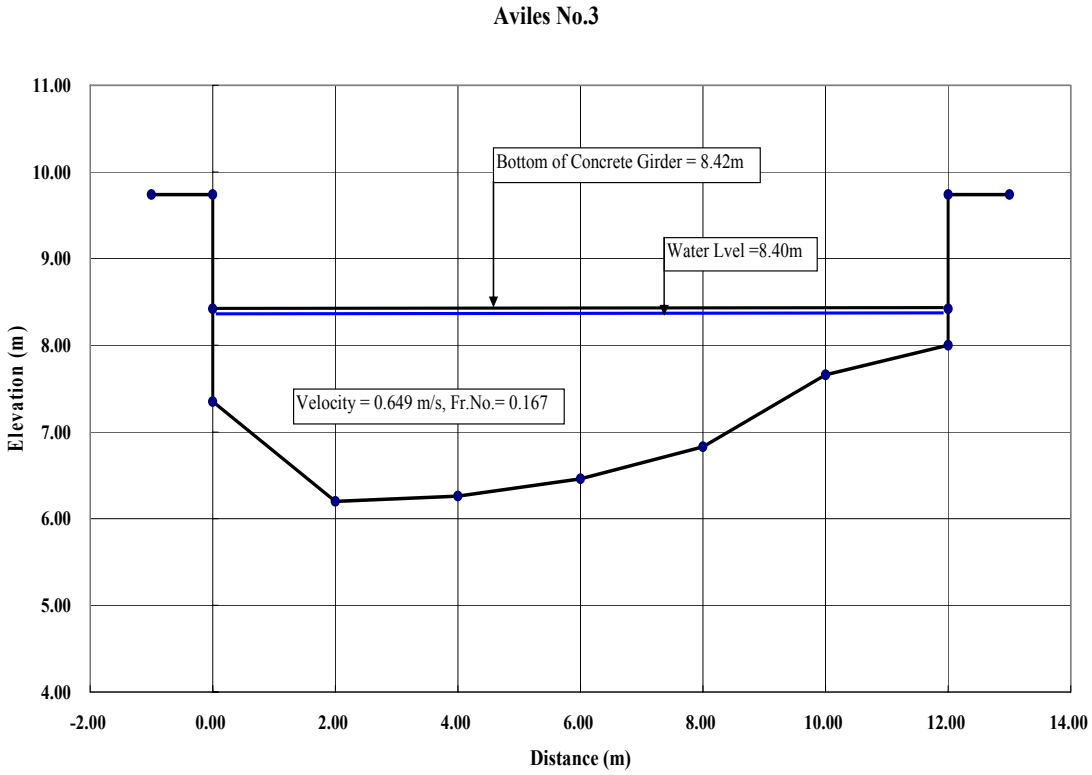
ここでも、橋台下のスラブの下高が 4.20ｍに対し、水面が 3.50ｍを想定しても、流速はわずか 0.027m/sec.であり、フルード数も 0.007 であり、これは、充分流下能力があるとの判断に立つことが可能である。したがって、Estero de Quiapo への二次流入排水路は、キアポ排水機場排水能力に見合った流下能力があるといえる。

2.3.2　アビレス・サンパロック排水機場排水路

判定に利用した横断測線地点は、図 1.2.1(1)で示す No.3 地点、並びに Estero de Sampaloc の 0＋000 地点、0＋339 地点、0＋506 地点である。これらについて、No.3 地点の断面データは開発調査時のものはないが、他の 3 地点は開発調査時の断面データは存在する。このため、No.3 地点については、想定流量を流すに必要な流速と水深を求め、総合的な判断を行い、他の 3 地点については、0＋000 地点からの縦断関係が分かるため、不等流計算を行い、総合的判断を行った。

① No.3 地点（Estero de Sampaloc）

Section	Area (km^2)	Q10(m^3/s)	Remarks
P.S.	3.284	15.6	Design and Works
Aviles No.3	2.550	12.1	Area Ratio Calculation

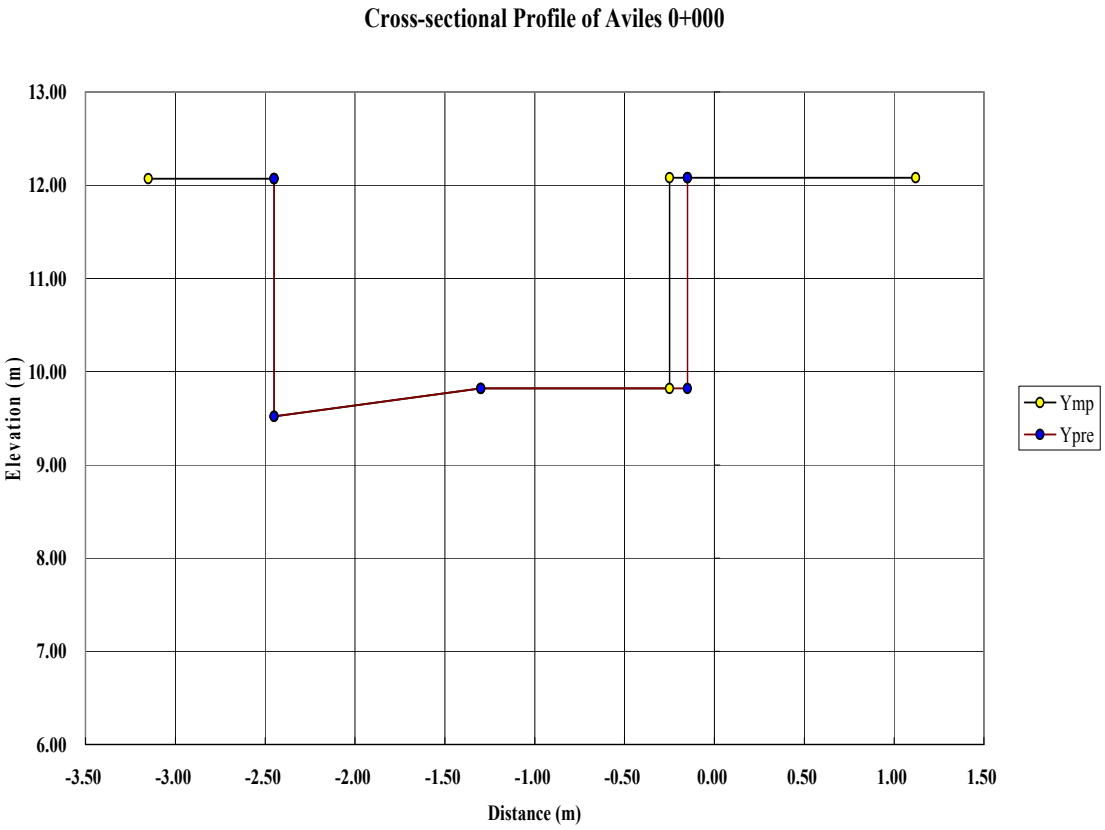


ここでは、橋台下のスラブの下高が 8.42ｍに対し、水面が桁下いっぱいの 8.40ｍを想定すれば、流速は 0.649m/sec.であり、フルード数も 0.167 であり、これは、流下能力があるとの判断に立つと簡単には結論づけることは出来ないが、周囲の状況を想定すると（現状報告での写真)、流下能力はあると判断される。

② 0+000 地点、0+339 地点、0+506 地点（Estero de Sampaloc）

Section	Area (km2)	Q10(m^3/s)	Remarks
Pumping Station	3.284	15.6	Design and Works
Aviles 0+000	1.931	9.2	Area Ratio Calculation
Aviles 0+339	1.516	7.2	Area Ratio Calculation
Aviles 0+506	1.312	6.2	Area Ratio Calculation

Estero de Samapaloc は 0+000 地点で Lacson Street 下にはいり、暗渠となっている。



この区間の下流端である 0+000 地点での出発水位を橋桁ぎりぎりの 12.0m で設定しても、流速は 1.7m/sec.を越える。しかし、その上流での他の 2 断面では、流速は 0.3m/sec.～0.5m/sec.程度であり、開水路としての流下能力はあると思われるが、そこから暗渠となる 0+000m地点では、ごみ等の問題もあり、この地点での流下能力に関しては、疑問が残る。すなわち、アビレス・サンパロック排水機場の排水能力に見合った断面とは言い難い。

2.3.3　トリパ・デ・ガリナ排水機場排水路

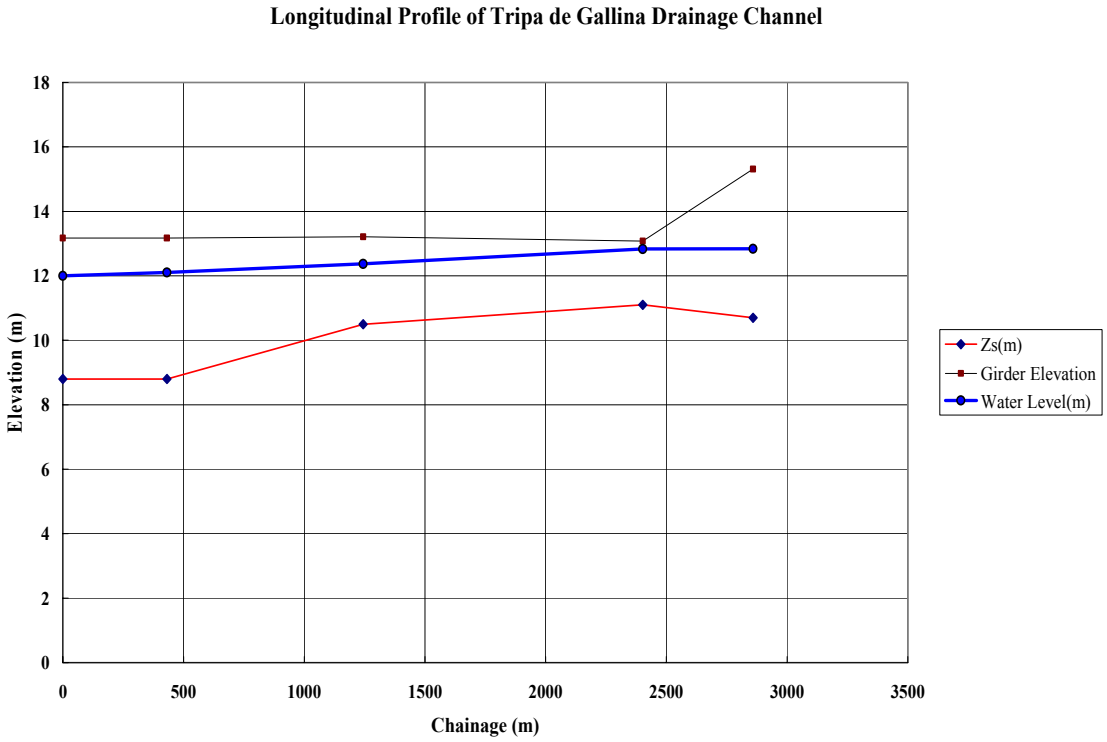
判定に利用した横断測線地点は、図 1.2.1(2)で示す 0+431 地点、1+244 地点、2+402 地点、2+859 地点の 4 地点である。2+859 地点は、前項で述べているように、リベルタッド排水機場との流域界地点とされている地点である。なお、これらの断面名は排水機場からの Estero de Tripa de Gallina 沿いの距離を示す。すなわち、2＋859 とは排水機場から 2,859m 地点を示す。

Estero de Tripa de Gallina は、縦断的なデータが得られているので、流末から、上流端までの不等流計算を実施し、これらの流下能力の判定を行った。なお、流末の排水機場については、直上流地点の 0+439 地点の断面を利用して計算を実施した。

① 0+431 地点、1+244 地点、2+402 地点、2+859 地点（Estero de Tripa de Gallina）

Section	Area (km^2)	Q10(m^3/s)	Remarks
Pumping Station	17.05	57.0	Design and Works
0+431	10.84	36.2	Area Ratio Calculation
1+244	5.49	18.4	Area Ratio Calculation
2+402	0.35	1.2	Area Ratio Calculation
2+859	0.35	1.2	Area Ratio Calculation

上記条件で不等流計算を実施したところ、以下のような結果が得られた。



（ここで、Zs は最深河床高を示す）

すなわち、ポンプ場で水面高を 12.0m に維持すると、ポンプ場の排水能力である $57m^3/sec$.に対応した流量は、各地点で流下可能であることが判る。

なお、上記で水位と桁下高が接近している 2+402 地点は、以下の写真に示すような状況になっている。

Estero de Tripa de Gallina 2+402 地点　（2007 年 3 月 9 日）

すなわち、桁下高が橋上の道路表面高よりかなり低くなっており、たとえ水面が桁下と同じになるような状態になっても、上流側で水位が上昇するが、水路としては流下能力を有していると判断される。

E　　排水機場ポンプ機器故障時の影響の検討

E　排水機場ポンプ機器故障時影響検討

1.　概　要

キアポ、アビレス・サンパロック、トリパ・デ・ガリナの排水機場の機器類の現状調査の結果、機器類は 20～30 年の長期の使用の結果、いつ運転中止に追い込まれても不思議ではない状況にあることが判明した。これら排水機場のポンプ機器が運転中止に追い込まれた場合、どのような影響がでるのかを水理的な方面から検討を行った。以下はその検討結果である。

2.　排水現況諸元

各排水機場の排水水理諸元は以下のようである。

排水機場	排水区域面積(km^2)	排水能力(m^3/s)
キアポ	2.29	10.8
アビレス・サンパロック	3.28	15.6
トリパ・デ・ガリナ	11.56	57.0

これら排水能力の諸元は、10 年確率雨量に対して、12 時間以内に排水することを条件として、設定されている。また、この間の許容湛水深は、20cm とされている。

また、計画（1974 年）に使用された短時間雨量の降雨強度曲線は以下の式が使用されている。

$$I = \frac{510.6}{(t+1)^{0.46}}$$

ここに、I：降雨強度(mm/hr)

ｔ：降雨継続時間（min）

3.　ポンプ運転中止時影響検討

ポンプ排水検討にかかる降雨強度曲線に関しては、2004 年から 2005 年にかけて行われたマニラ首都圏中心地域排水機能向上調査において短時間降雨強度曲線の見直しが行われており、以下のものが採用されている。本検討では、これを使用した。

$$I = \frac{1216}{(t+11)^{0.63}}$$

4.　流出ハイドログラフ

上記の短時間降雨強度曲線（10 年確率）により、キアポ、アビレス・サンパロック、トリパ・デ・ガリナそれぞれの排水機場への流出ハイドログラフの算定を行った。これは、合成合理式により行った。この際の洪水到達時間流出係数はそれぞれ次の値を 2005 年開発調査での結果から使用した。

排水機場	洪水到達時間（hr）	流出係数
キアポ	1.00	0.737
アビレス・サンパロック	1.39	0.715
トリパ・デ・ガリナ	1.39	0.619

なお、計画降雨ハイエトグラフとしては、前方集中型を採用した（1974 年報告書準拠）。算定された流入ハイドログラフは表 4-1～4-4、ならびに図 4-1～4-4 に示されている。

5.　排水計算と湛水量計算

キアポ、アビレス・サンパロック排水機場の流域は、既往報告書ではそれぞれ独立した流域を有している形になっているが、実質的には共通した流域を有していることから、実質的なポンプ運転影響比較検討のために、本節での排水・湛水比較検討においては、それぞれの流出量は合算したものを使用し、湛水エリアも共通のコンター図を使用している。

計算結果によれば、それぞれの場合について以下に示すような結果が得られた。

ポンプ運転中止時

排水機場	氾濫ボリューム(m^3)	氾濫水位(m)	氾濫面積(m^2)
キアポ ＋ アビレス・サンパロック	906,390	1.61	1,804,091
トリパ・デ・ガリナ	1,626,804	2.21	2,349,484

ポンプ運転通常時

排水機場	氾濫ボリューム(m^3)	氾濫水位(m)	氾濫面積(m^2)
キアポ	476,128	1.50	1,014,662
アビレス・サンパロック	372,534	1.42	854,257
キアポ ＋ アビレス・サンパロック	247,757	1.32	661,053
トリパ・デ・ガリナ	387,169	1.88	1,182,492

上記表において、キアポ排水機場運転中止時の氾濫水位は、アビレス・サンパロック排水機場のポンプ運転のみが行われている場合に相当し、アビレス・サンパロック排水機場運転中止時の氾濫水位は、キアポ排水機場のポンプ運転のみが行われている

場合に相当する。なお、それぞれの場合の時間経過による排水・湛水状況の変化を図5-1～5-4に示す。

上記の数値は、2004年から2005年に行われた開発調査時に作成された対象地域のコンター図をもとにして得られている。面積-ボリューム曲線も同コンター図を基にして今回作成し、キアポ並びにアビレス・サンパロック排水域については、共通エリアであることから図5-5に示し、トリパ・デ・ガリナについては、図5-6に示す。

ポンプ運転中止時の氾濫湛水深は、上記コンター図に基づき、以下のように算定されている。

排水機場	氾濫水深(m)	氾濫水位	最低地盤高
キアポ	0.42	1.42	1.00
アビレス・サンパロック	0.50	1.50	1.00
キアポ + アビレス・サンパロック	0.61	1.61	1.00
トリパ・デ・ガリナ	0.21	2.21	2.00

なお、氾濫水深は、排水域内での排水路内を除く最も低い地盤高（コンター図に基づく）と氾濫水位との差として算定している。

キアポ並びにアビレス・サンパロックの氾濫域での市街化状況については、図 5-7に示し、コンター図は、図5-8に示す。

キアポ及びアビレス・サンパロック流域については、両排水機場の同時運転中止時の影響がもっとも大きく、これら両者の通常運転時の氾濫域と、同時運転中止時の氾濫域を、図5-9に示した。図で、青色の範囲は通常運転時の氾濫域を示し、水色の部分は、運転中止時の氾濫域を示す。ただし、黄色の部分は、ともに氾濫域内に入らない部分である。なおこれらは、排水路（エステロ）エリアを含むが、エステロはほぼ標高1.0m内にあるエリアである。

一方、トリパ・デ・ガリナ排水域に関しては、市街化状況を図5-10に示し、コンター図を、図5-11に示す。また、氾濫域の広がりは図5-12に示す。

ポンプ運転通常時における氾濫水位は1.88mと算定されているが、コンター図によれば、標高2.0m以下の部分は、エステロ内ならびに、トリパ・デ・ガリナ排水機場上流にある貯水池内の部分となっており、実質的な氾濫被害はない。

表　4-1　キアポのみ運転の場合の流出・排水量・湛水計算

time(mn)	runoff (m^3/s)	pump (m^3/s)	step volume with pump (m^3)	sum-volume with pump (m^3)	step volume without pump (m^3)	sum-volume without pump (m3)
0.0	0	0	0	0	0	0
60.0	71.40	10.8	109,086	109086	128,526	128,526
83.4	74.35	10.8	87,152	196238	102,315	230,841
120.0	46.11	10.8	108,544	304782	132,260	363,102
166.8	26.07	10.8	71,020	375801	101,346	464,448
180.0	24.38	10.8	11,424	387226	19,978	484,426
240.0	18.98	10.8	39,160	426386	78,040	562,466
300.0	15.90	10.8	23,908	450294	62,788	625,254
360.0	13.78	10.8	14,552	464846	53,432	678,686
420.0	12.26	10.8	7,996	472842	46,876	725,562
480.0	11.17	10.8	3,286	476128	42,166	767,728
540.0	10.27	10.8	-290	475838	38,590	806,318
600.0	9.54	10.8	-3,223	472615	35,657	841,975
660.0	8.92	10.8	-5,664	466951	33,216	875,191
720.0	8.42	10.8	-7,681	459270	31,199	906,390

表　4-2　アビレス・サンパロックのみ運転の場合の流出・排水量・湛水計算

time(mn)	runoff (m^3/s)	pump (m^3/s)	step volume with pump (m^3)	sum-volume with pump (m^3)	step volume without pump (m^3)	sum-volume without pump (m3)
0.0	0	0	0	0	0	0
60.0	71.40	15.6	100,446	100446	128,526	128,526
83.4	74.35	15.6	80,413	180859	102,315	230,841
120.0	46.11	15.6	98,003	278862	132,260	363,102
166.8	26.07	15.6	57,541	336403	101,346	464,448
180.0	24.38	15.6	7,623	344026	19,978	484,426
240.0	18.98	15.6	21,880	365906	78,040	562,466
300.0	15.90	15.6	6,628	372534	62,788	625,254
360.0	13.78	15.6	-2,728	369806	53,432	678,686
420.0	12.26	15.6	-9,284	360522	46,876	725,562
480.0	11.17	15.6	-13,994	346528	42,166	767,728
540.0	10.27	15.6	-17,570	328958	38,590	806,318
600.0	9.54	15.6	-20,503	308455	35,657	841,975
660.0	8.92	15.6	-22,944	285511	33,216	875,191
720.0	8.42	15.6	-24,961	260550	31,199	906,390

表　4-3　キアポ及びアビレス・サンパロック双方を運転の場合の流出・排水量・湛水計算

time(mm)	runoff of Aviles+Quiapo (m^3/s)	pump (m^3/s)	step volume with pump (m^3)	sum-volume with pump (m^3)	step volume without pump (m^3)	sum-volume without pump (m^3)
0.0	0.00	0	0	0	0	0
60.0	84.14	26.4	103,924	103,924	151,444	151,444
83.4	92.05	26.4	86,618	190,542	123,683	275,128
120.0	58.70	26.4	107,554	298,097	165,529	440,657
166.8	32.13	26.4	53,400	351,496	127,531	568,187
180.0	30.14	26.4	3,752	355,248	24,660	592,848
240.0	23.42	26.4	1,376	356,624	96,416	689,264
300.0	19.59	26.4	-17,615	339,009	77,425	766,689
360.0	16.97	26.4	-29,226	309,783	65,814	832,503
420.0	15.09	26.4	-37,340	272,443	57,700	890,203
480.0	13.74	26.4	-43,163	229,281	51,877	942,081
540.0	12.63	26.4	-47,585	181,695	47,455	989,535
600.0	11.72	26.4	-51,207	130,489	43,833	1,033,369
660.0	10.97	26.4	-54,190	76,299	40,850	1,074,219
720.0	10.35	26.4	-56,671	19,628	38,369	1,112,588

表　4-4　トリパ・デ・ガリナを運転の場合の流出・排水量・湛水計算

time(mn)	rainfall Intensity (mm/hr)	sum-rainfall (mm)	step rainfall (mm)	step rainfall intensity at time (mm)	runoff (m^3/s)	pump (m^3/s)	step volume with pump (m^3)	sum-volume with pump (m^3)	step volume without pump (m^3)	sum-volume without pump (m^3)
0.0	0	0	0		0	0.0	0	0	0	0
74.4	73.8	91.52	91.52	73.81	146.72	57.0	200,262	200262	327,486	327,486
148.8	49.7	123.35	31.82	25.66	51.02	57.0	186,907	387169	441,355	768,841
223.2	39.1	145.42	22.08	17.80	35.39	57.0	-61,587	325582	192,861	961,702
297.6	32.9	162.97	17.54	14.15	28.12	57.0	-112,691	212891	141,757	1,103,459
372.0	28.7	177.79	14.83	11.96	23.77	57.0	-138,635	74255	115,813	1,219,271
446.4	25.6	190.77	12.98	10.47	20.81	57.0	-154,945	-80689	99,503	1,318,775
520.8	23.3	202.41	11.64	9.38	18.65	57.0	-166,359	-247048	88,089	1,406,864
595.2	21.5	213.01	10.60	8.55	16.99	57.0	-174,891	-421939	79,557	1,486,421
669.6	20.0	222.78	9.77	7.88	15.66	57.0	-181,562	-603500	72,886	1,559,308
744.0	18.7	231.87	9.09	7.33	14.58	57.0	-186,952	-790452	67,496	1,626,804

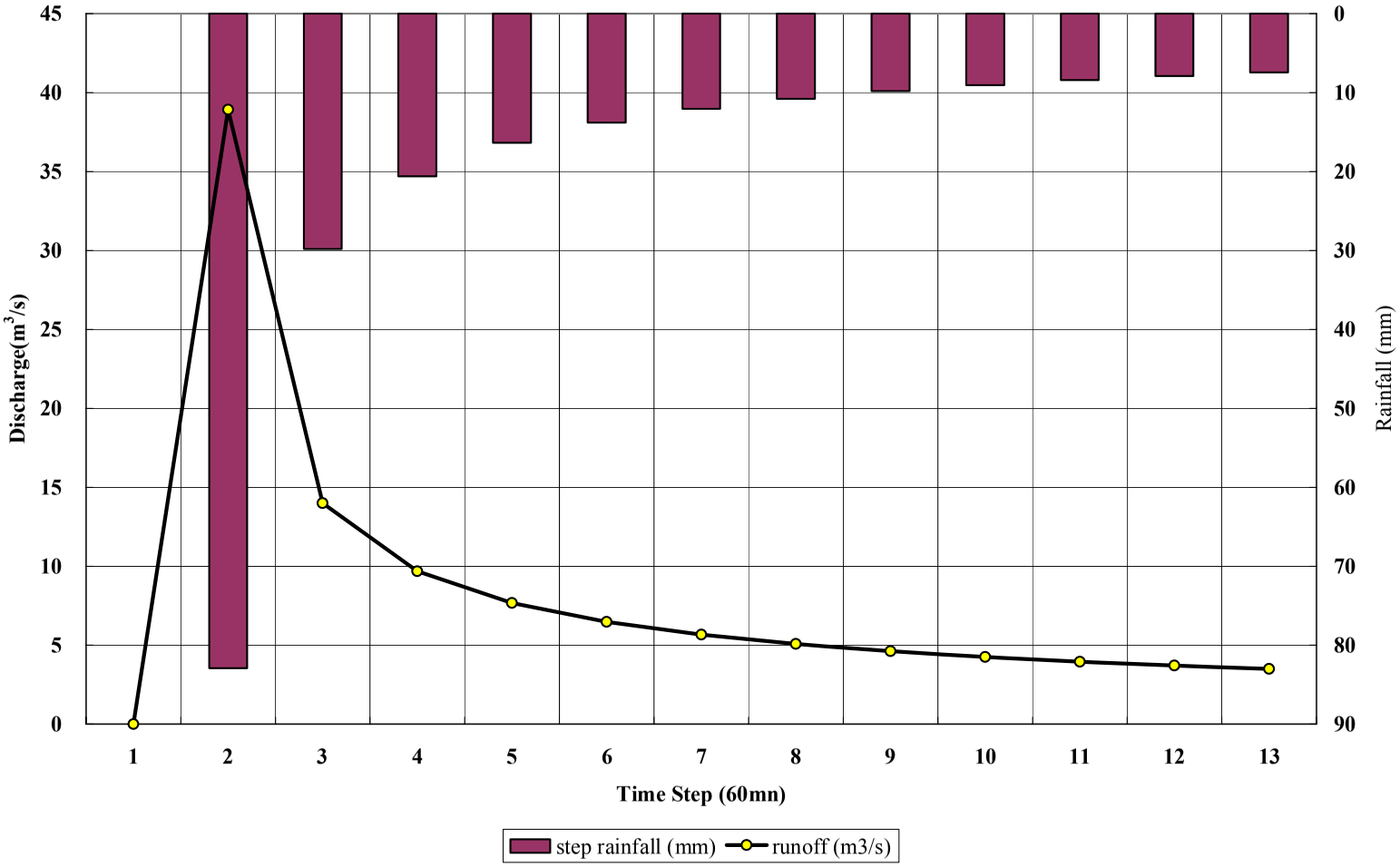


図　4-1　キアポ排水域　計画雨量及び流出グラフ

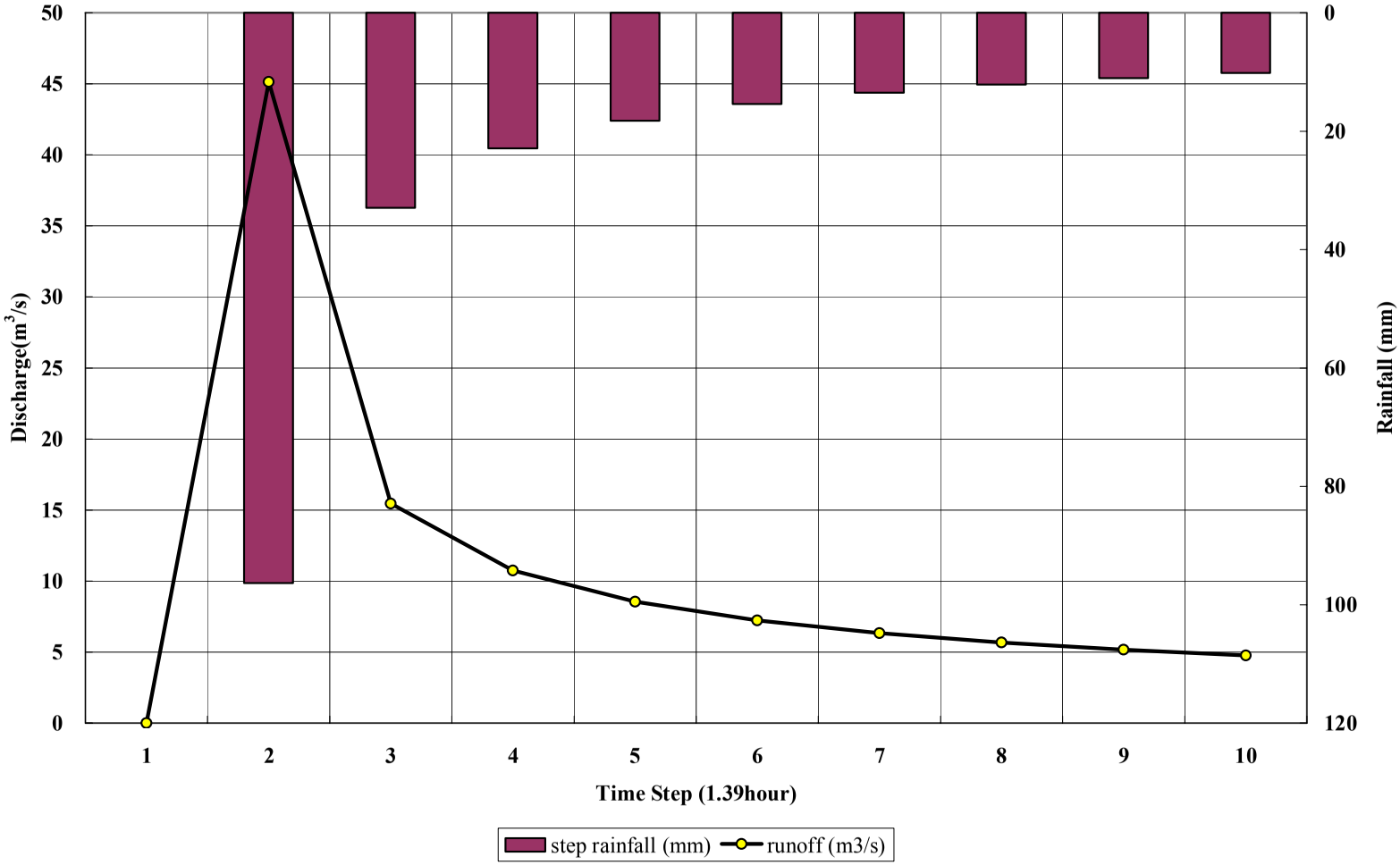


図　4-2　アビレス・サンパロック排水域　計画雨量及び流出グラフ

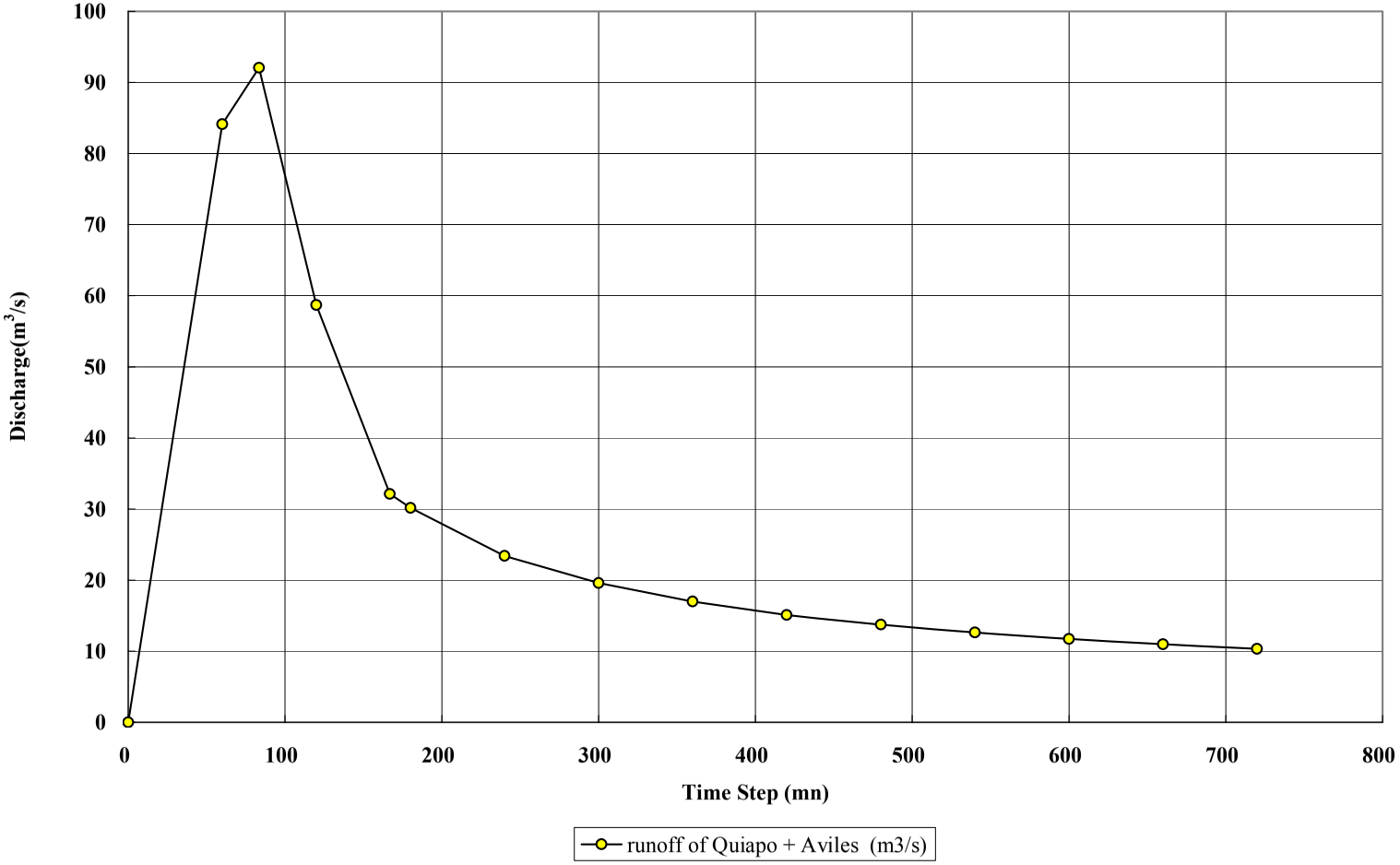


図　4-3　キアポ及びアビレス・サンパロック排水域　流出グラフ

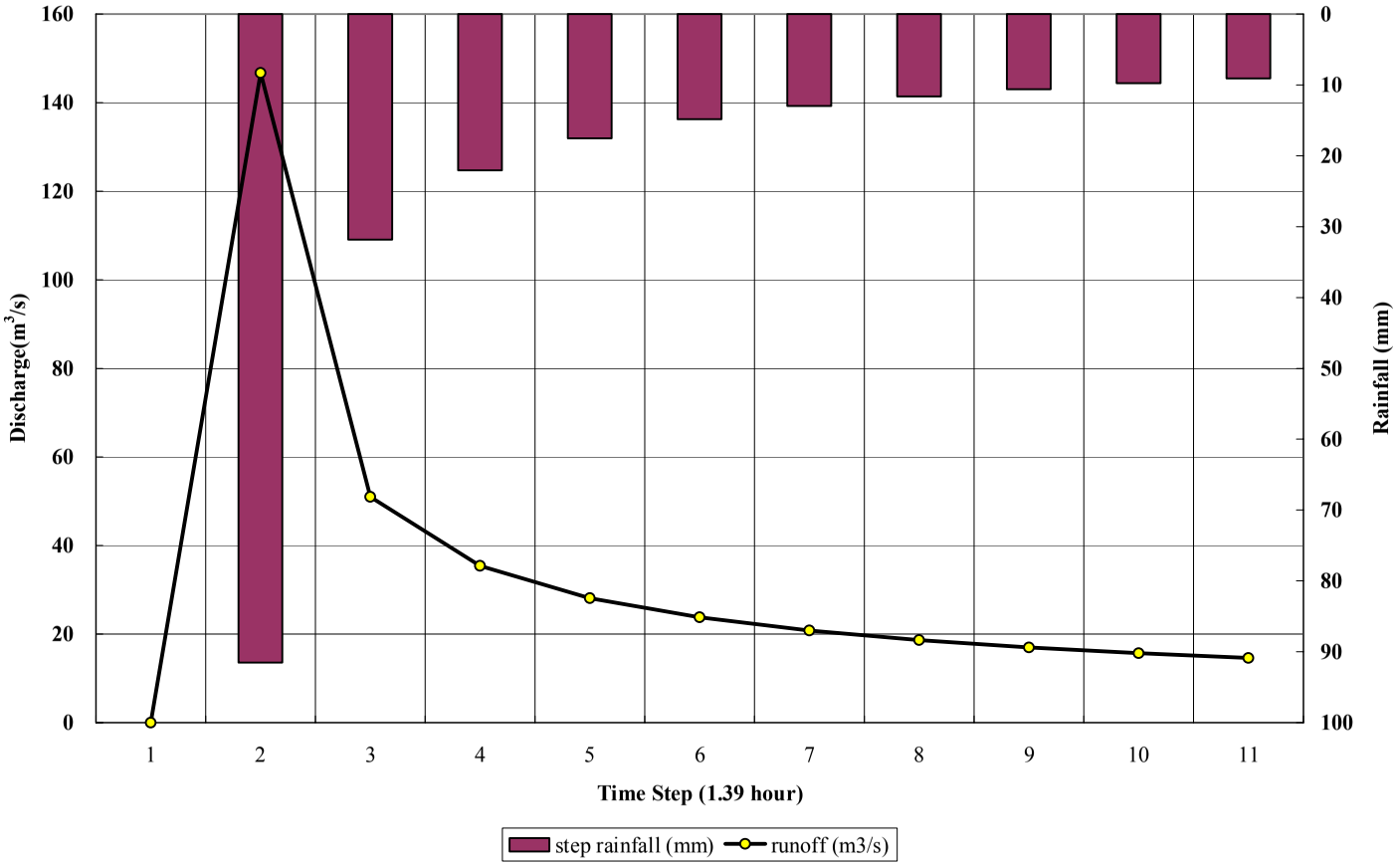


図　4-4　トリパ・デ・ガリナ排水域　計画雨量及び流出グラフ

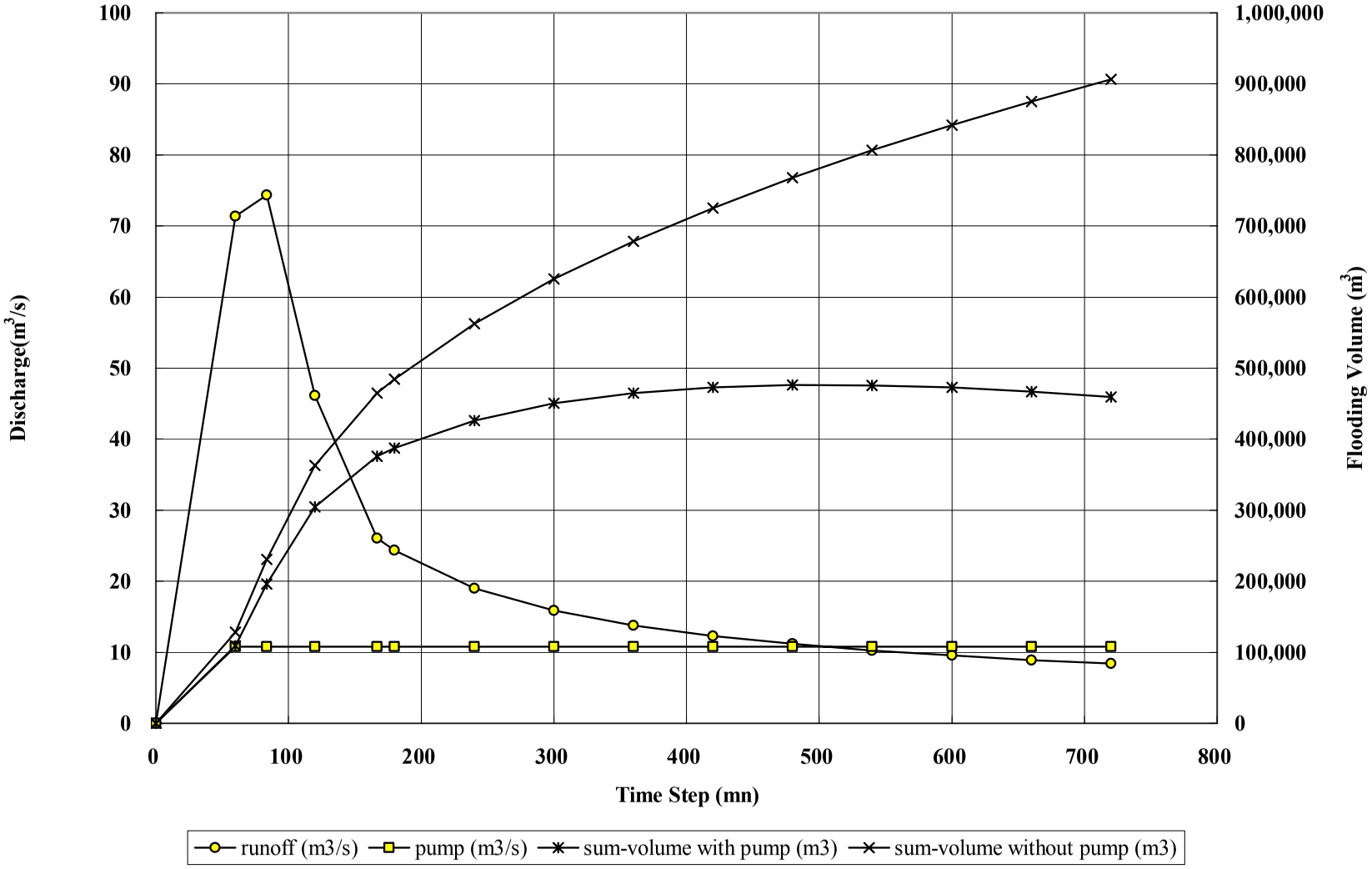


図　5-1　キアポ排水機場のみ運転時　排水・湛水状況図

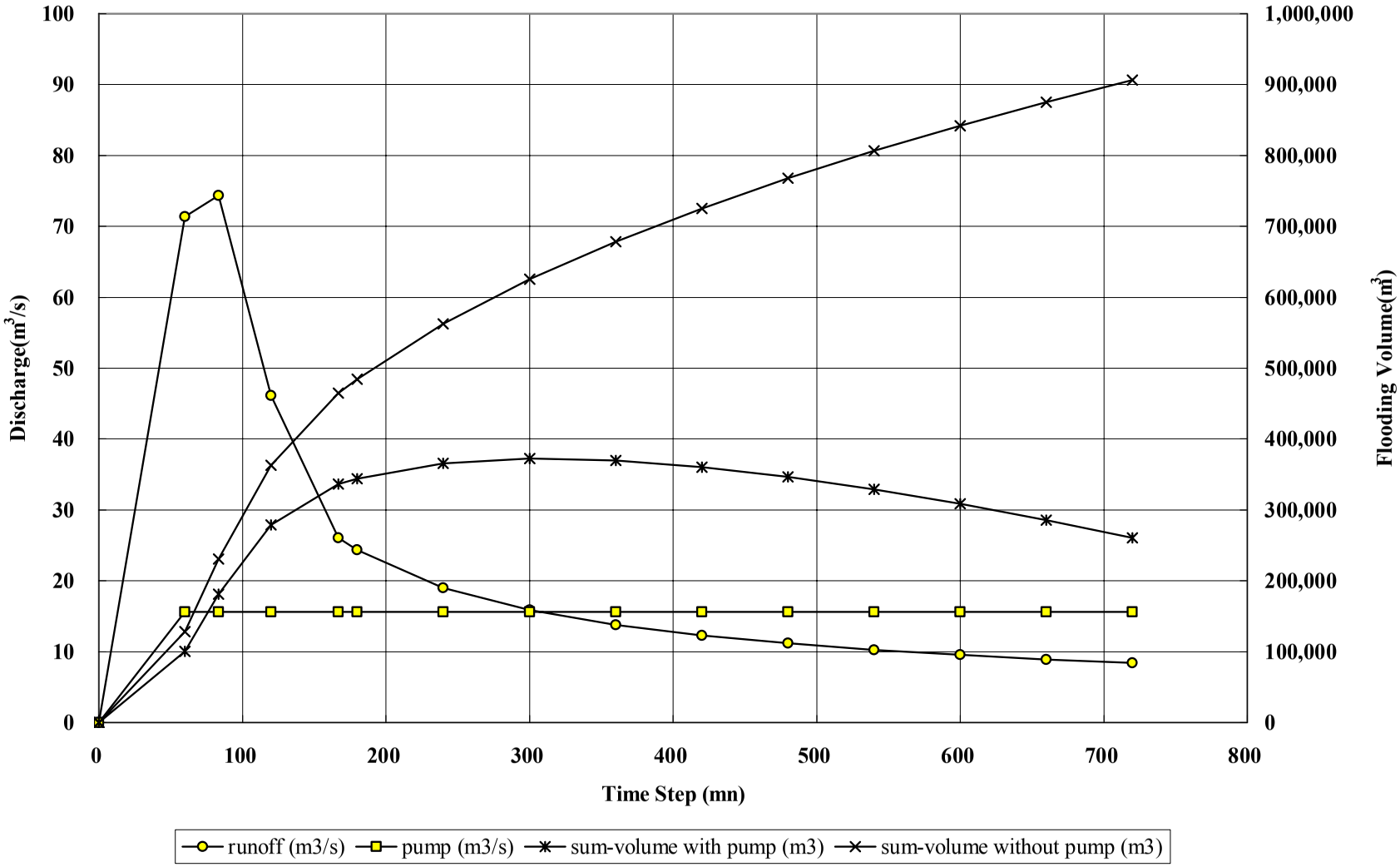


図　5-2　アビレス・サンパロック排水機場のみ運転時　排水・湛水状況図

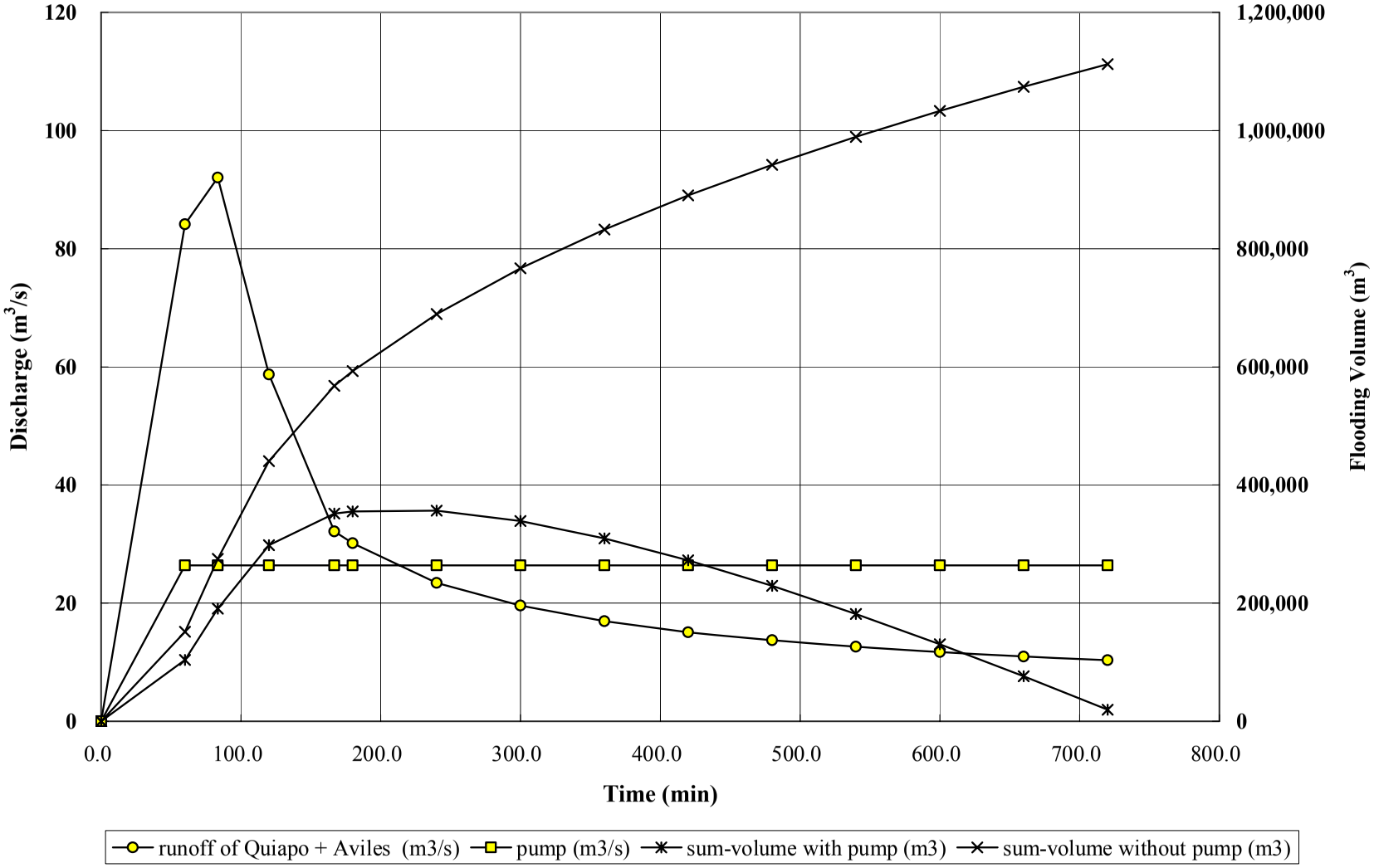


図　5-3　キアポ及びアビレス・サンパロック排水機場増俸運転時　排水・湛水状況図

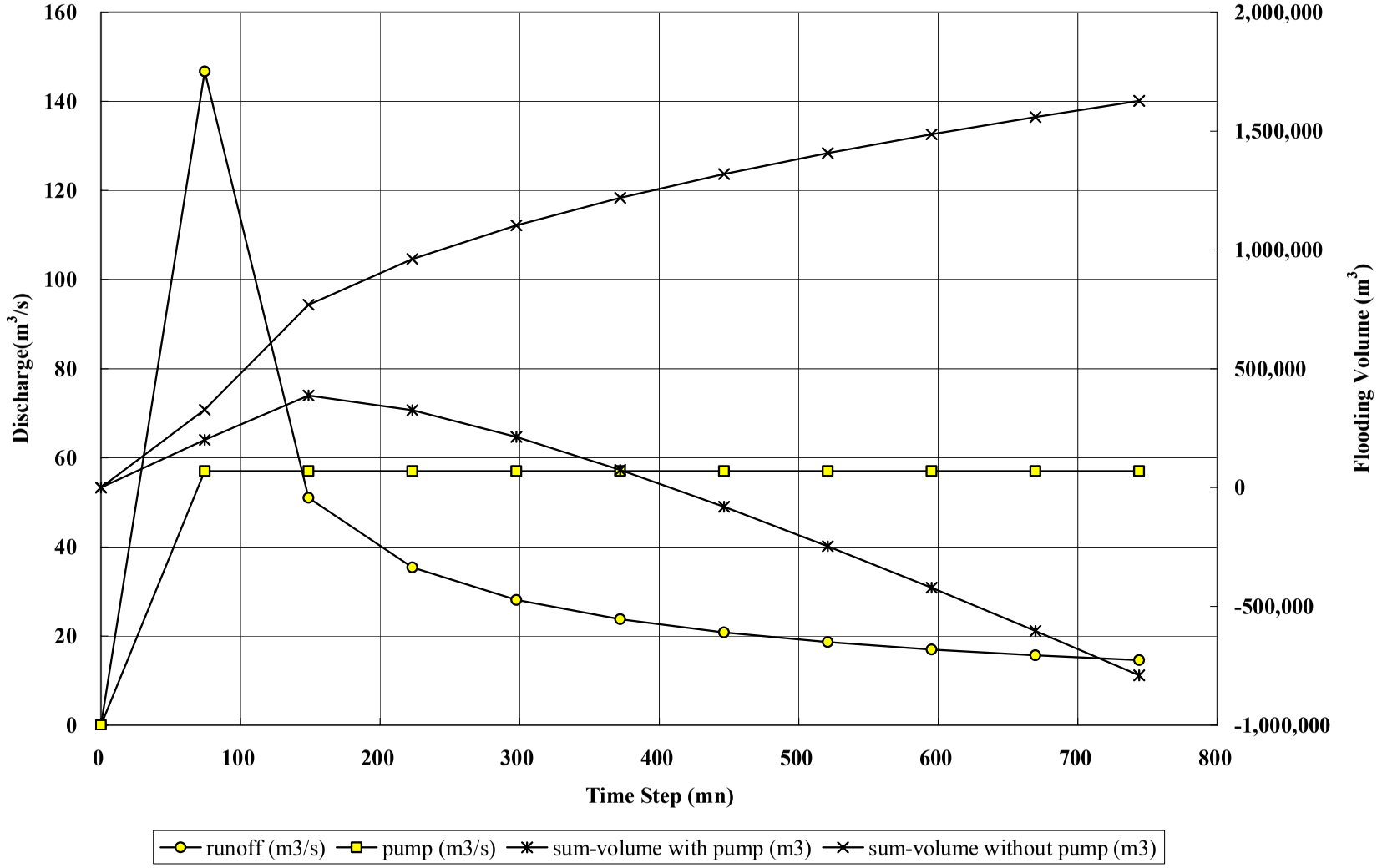


図　5-4　トリパ・デ・ガリナ排水機場運転時　排水・湛水状況図

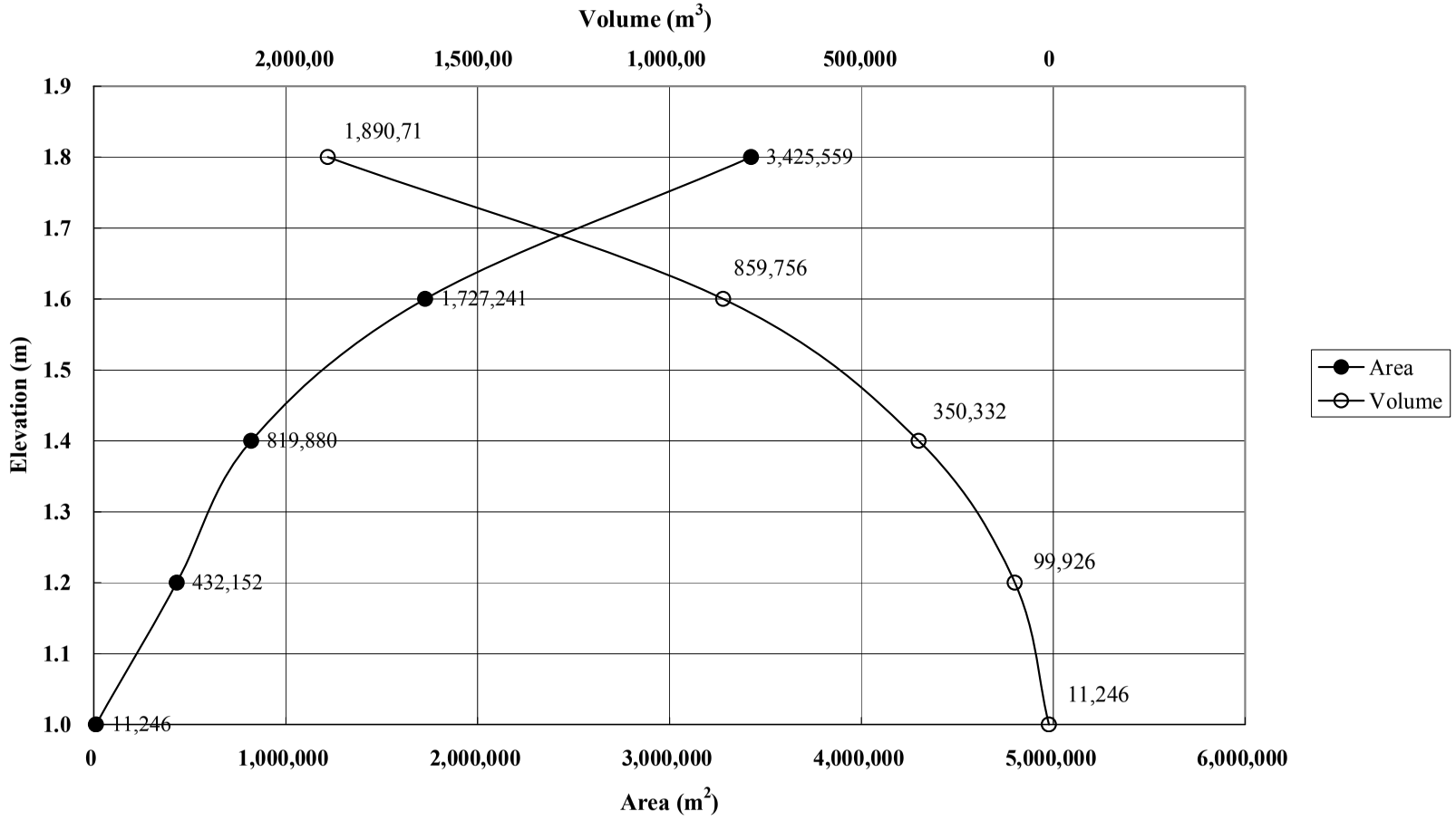


図　5-5　キアポ及びアビレス・サンパロック排水域 Area - Volume Curve

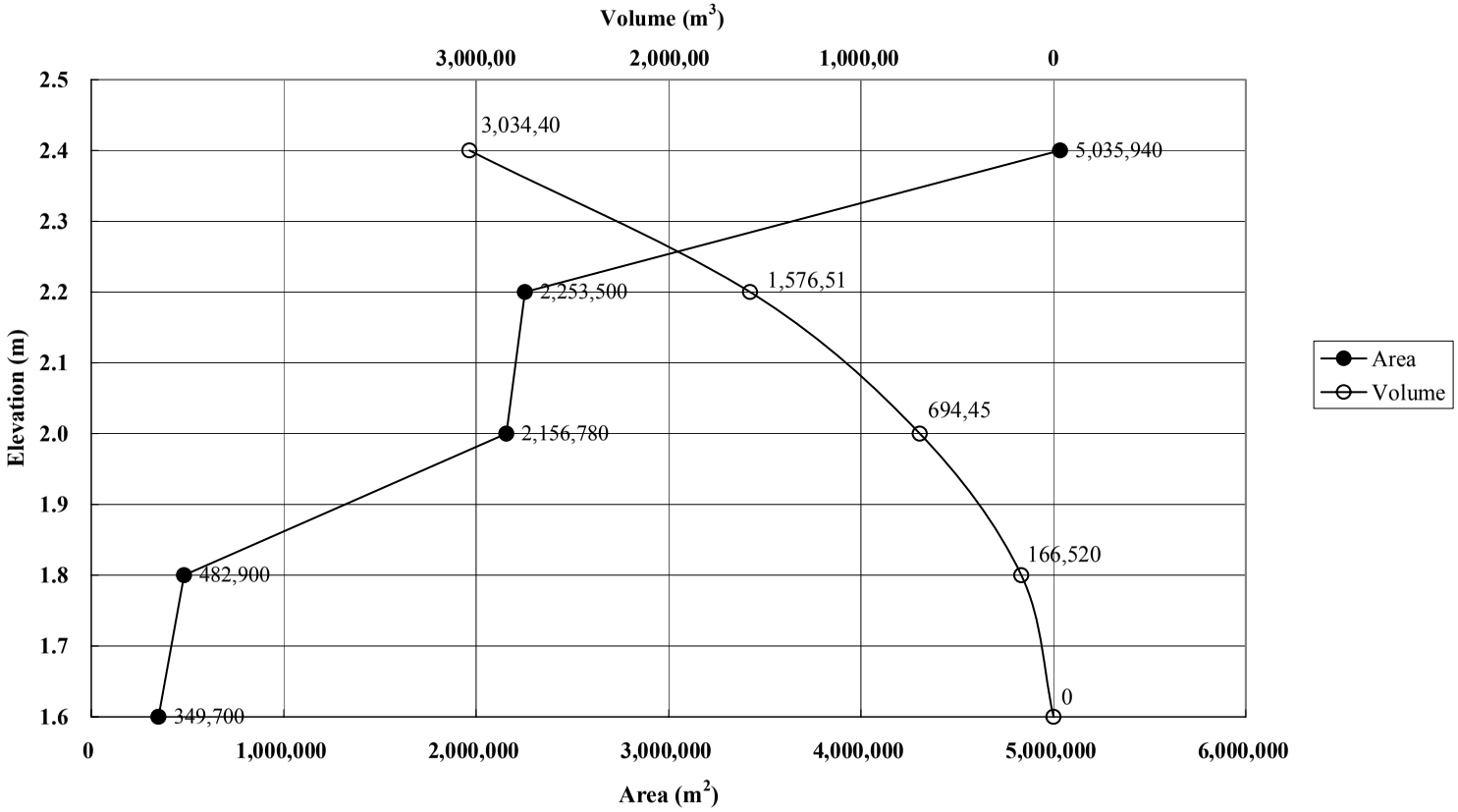


図　5-6　トリパ・デ・ガリナ排水域 Area – Volume Curve

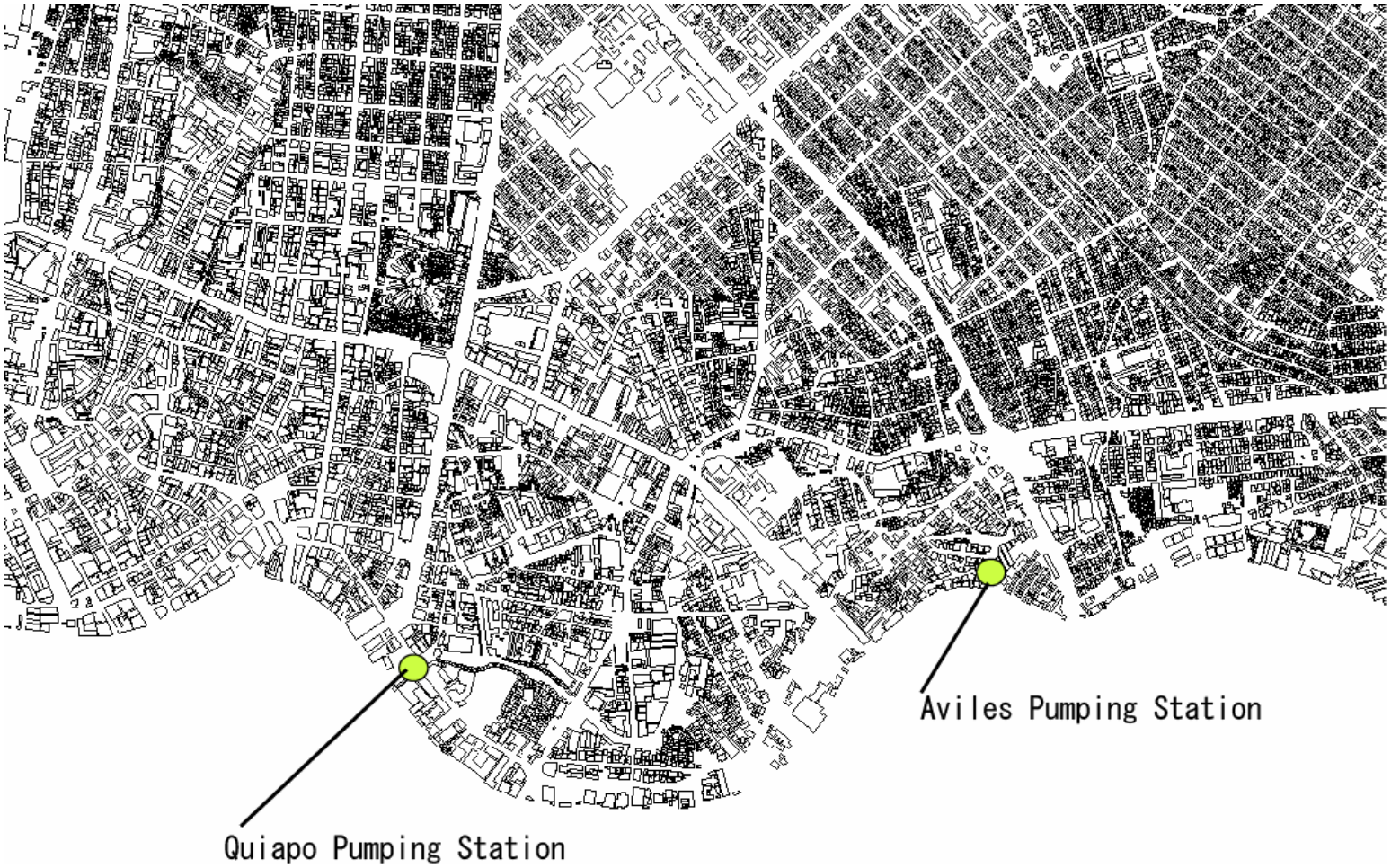


図　5-7　キアポ及びアビレス・サンパロック排水域市街化状況図

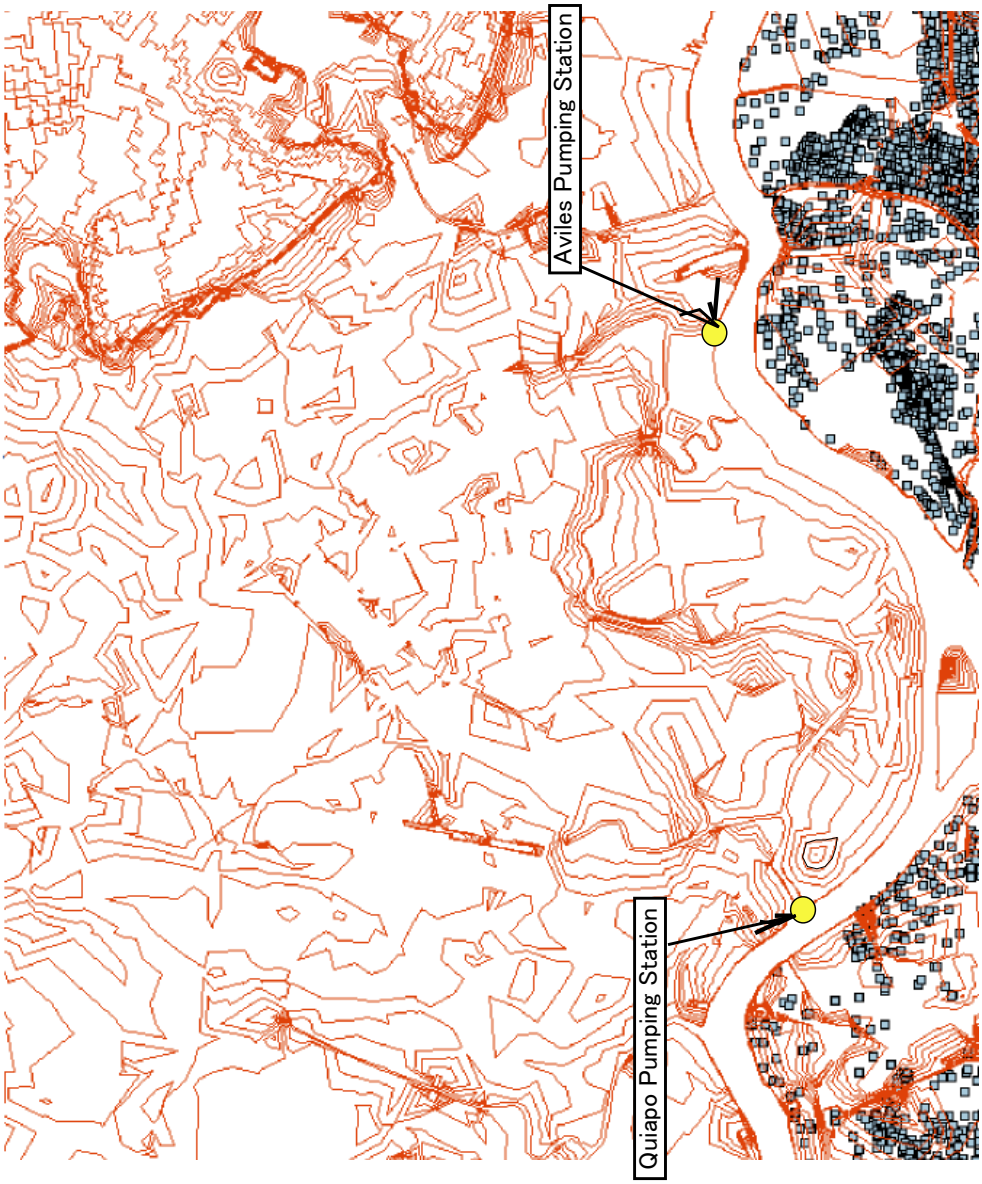


図　5-8　キアポ及びアビレス・サンパロック排水域コンター図

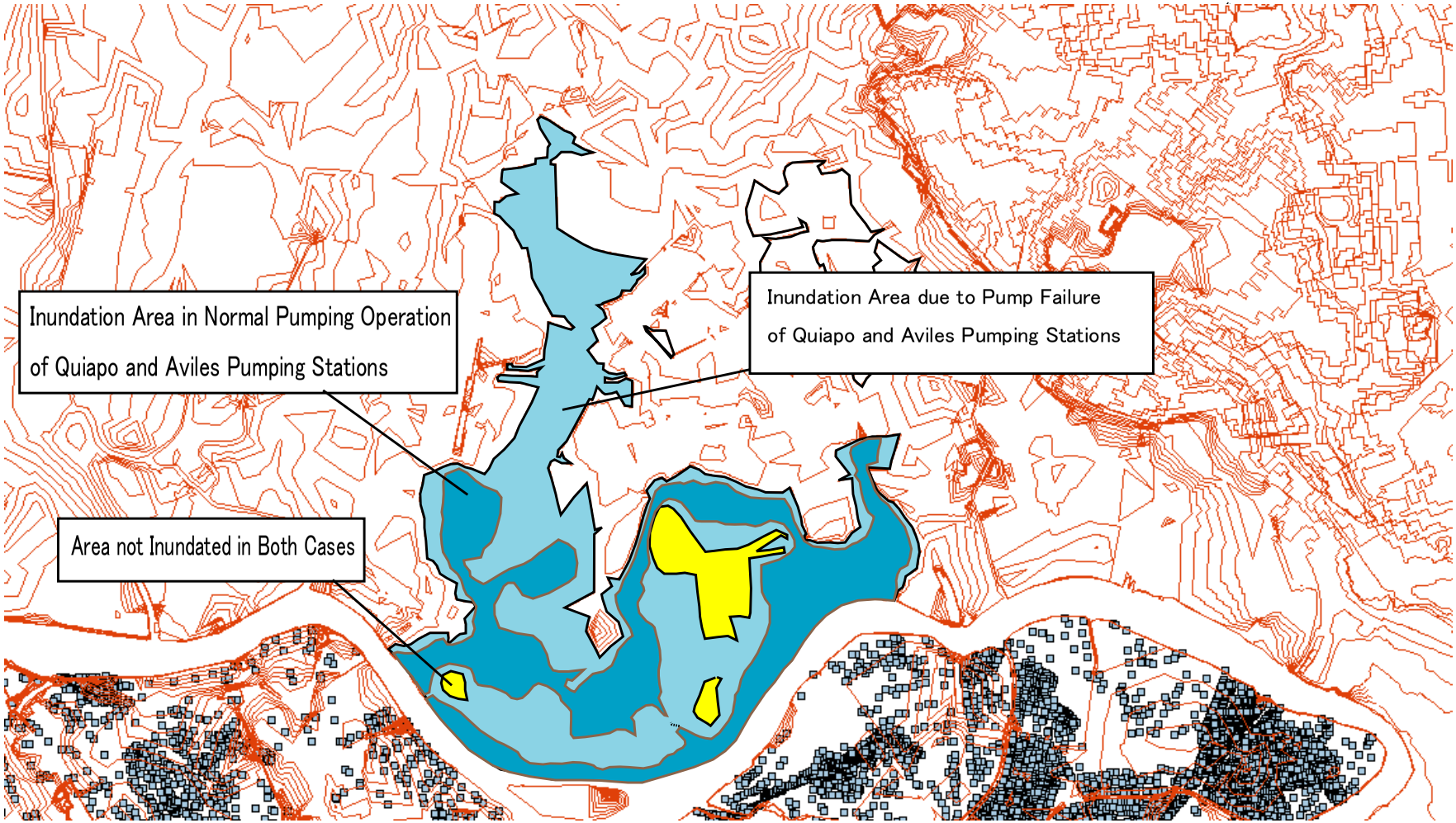


図　5-9　キアポ及びアビレス・サンパロック排水域氾濫予想図

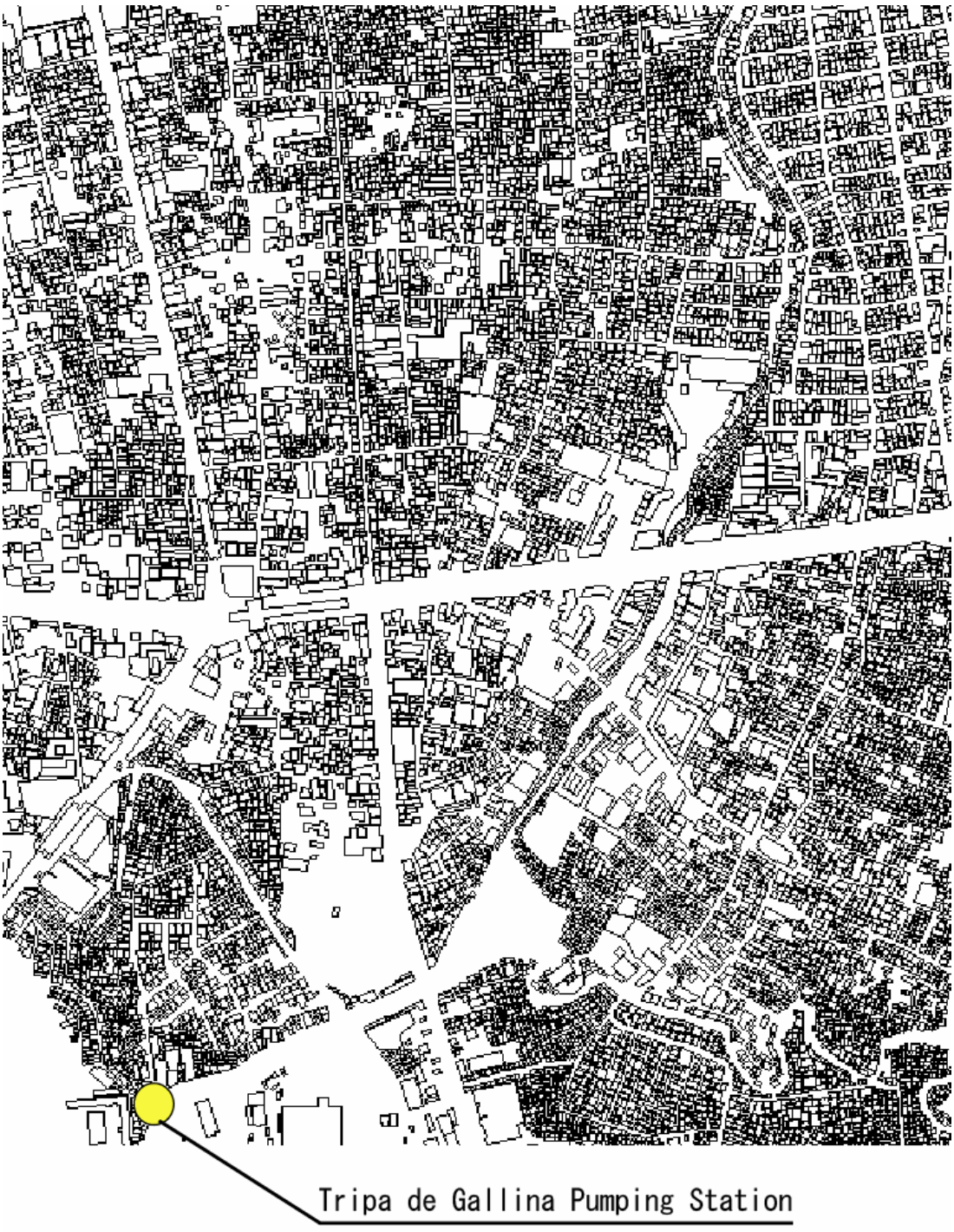


図　**5-10**　トリパ・デ・ガリナ排水域市街化状況図

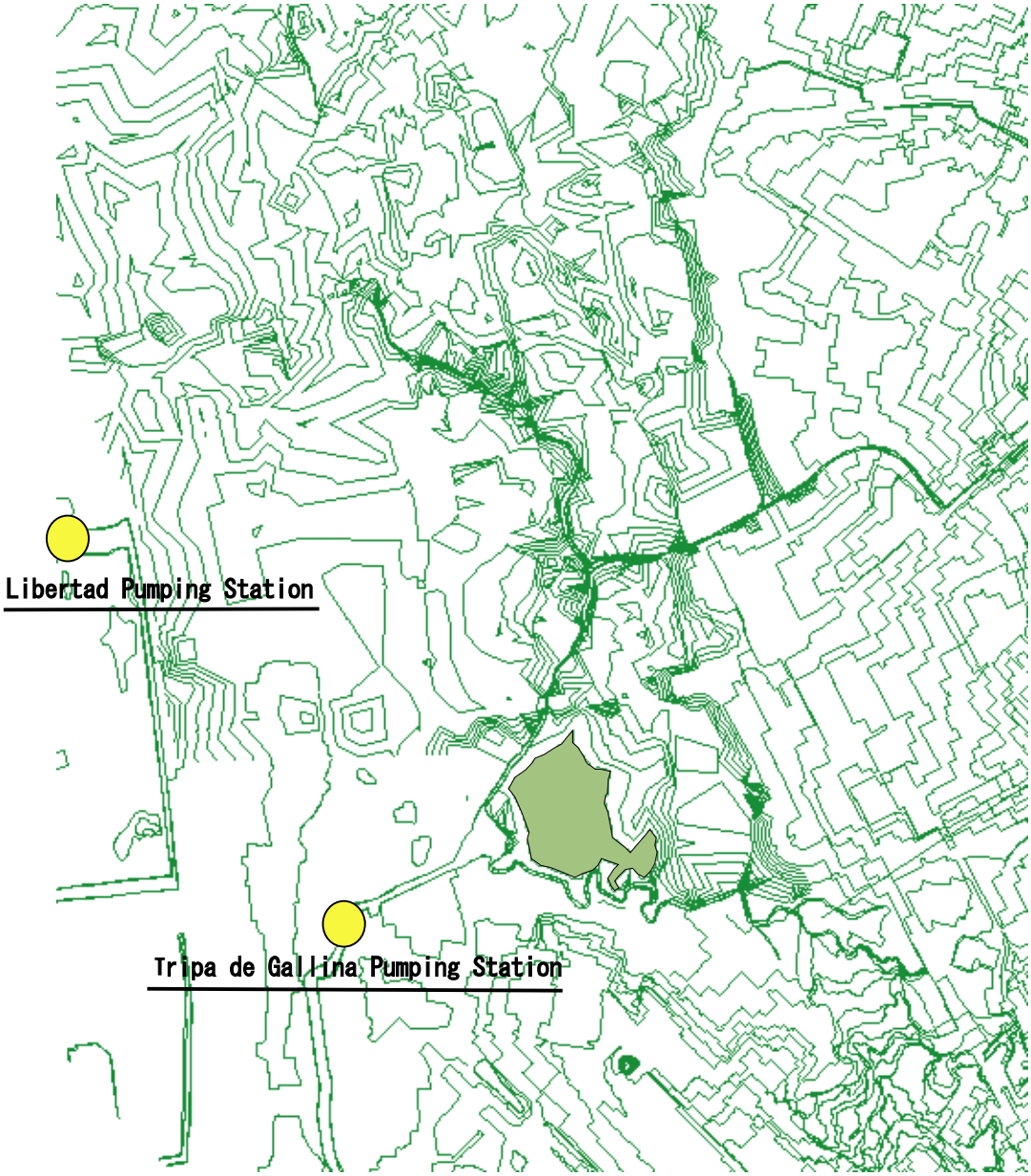


図　5-11　トリパ・デ・ガリナ排水域コンター図

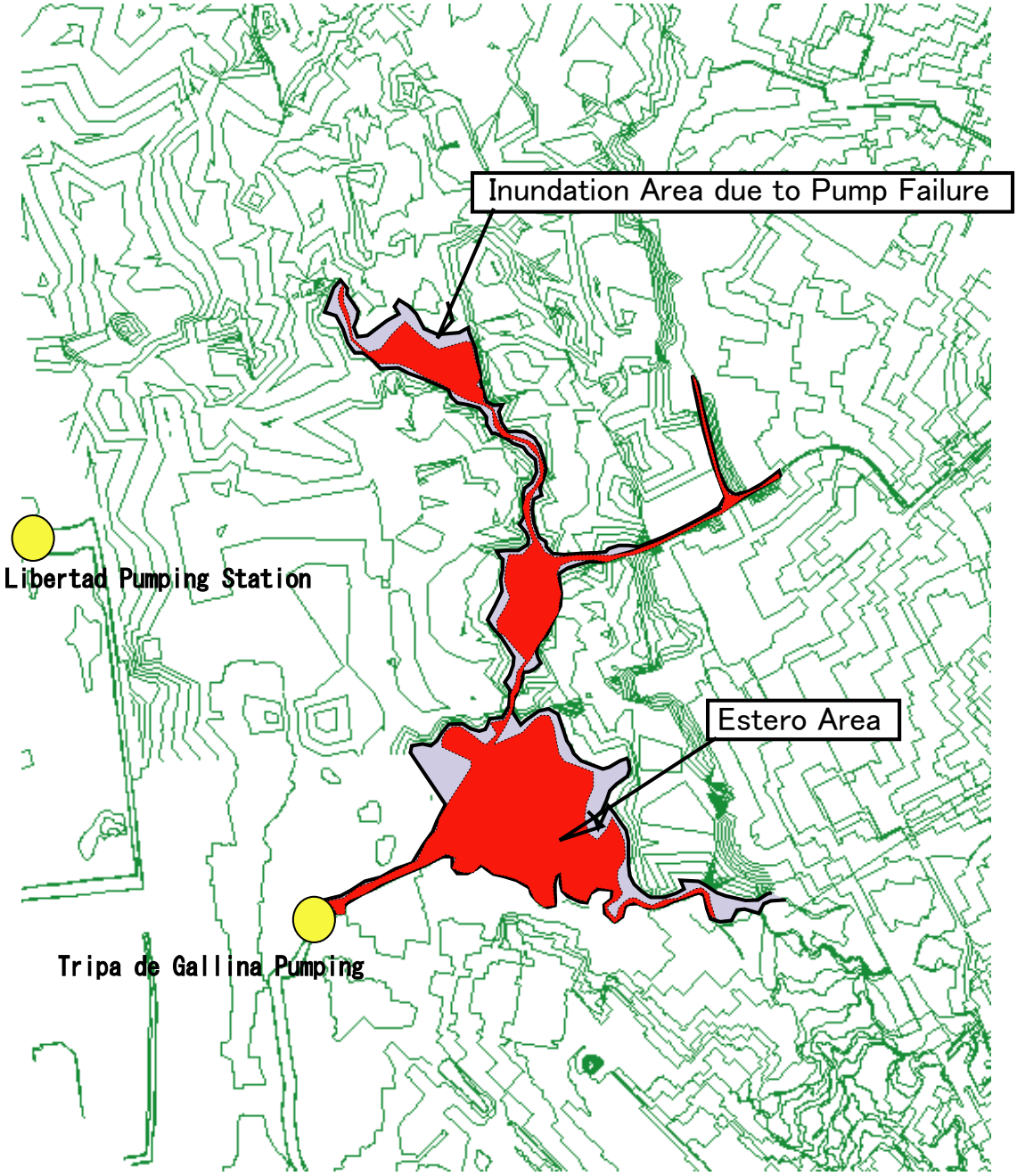


図　5-12　トリパ・デ・ガリナ排水域氾濫予想図

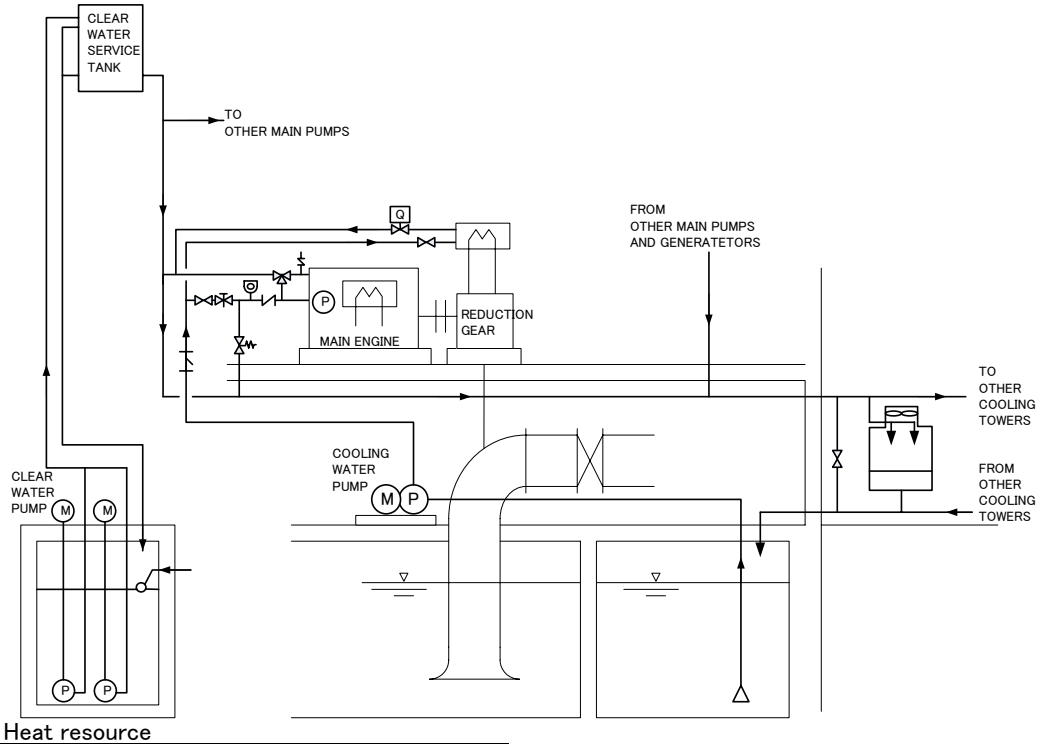
F　　補助機器仕様計算書

1. キアポ排水機場補助機器仕様計算書 (QUIAPO)

1.1 冷却機器仕様計算書

1.1.1 FLOW SHEET OF COOLING WATER EQUIPMENTS

The cooling water system is composed from following equipments described in flow sheet and equipments of heat resource are shown in table.



Heat resource

	Output (kW)	Sets
Main engine	96	4
Reduction gear	96	4
Generator engine	70	2

1.1.2 REQUIRED COOLING WATER CAPACITY

Total required cooling water capacity is determined by following equation.

$$Q_{CW} = \Sigma Q$$

(1) Required cooling water capacity for Main Engine

Required water capacity is calculated below.

$$Q_{ME} = \frac{Q_c}{60 \times \Delta T \times C \times \gamma}$$

Q_{ME} : Required water capacity for main engine (L/min)

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

Q_c : Quantity of heat of Main Engine (kJ/h)

$$Q_c = P_E \times B_E \times H_U \times \tau$$

P_E : Engine output 96 kW

B_E : Fuel consumption 0.34 kg/kW/h

H_U : Net calorific value of diesel oil 42700 MJ/kg

τ : Heat radiation factor 0.3

$$Q_{ME} = \frac{418{,}118}{60 \times 15 \times 4.19 \times 1.0}$$

$$= 110.9 \text{ L/min} \Rightarrow 120 \text{ L/min}$$

(2) Required cooling water capacity for Reduction Gear

Required water capacity is calculated below.

$$Q_G = \frac{60 \times P_E \times (1 - \eta)}{\Delta T \times C \times \gamma}$$

Q_G : Required water capacity for reduction gear (L/min)

P_E : Engine output 96 kW

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

η : Efficiency of reduction gear 0.96

$$Q_G = \frac{60 \times 96 \times (1 - 0.96)}{15 \times 4.19 \times 1.0}$$

$$= 3.7 \text{ L/min} \Rightarrow 10 \text{ L/min}$$

(3) Required cooling water capacity for Generator Engine

Required water capacity is calculated below.

$$Q_{GE} = \frac{Q_c}{60 \times \Delta T \times C \times \gamma}$$

Q_{GE} : Required water capacity for generator engine (L/min)

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

Q_c : Quantity of heat of Main Engine (kJ/h)

$$Q_c = P_E \times B_E \times H_U \times \tau$$

P_E : Engine output 70 kW

B_E : Fuel consumption 0.34 kg/kW/h

H_U : Net calorific value of diesel oil 42700 MJ/kg

τ : Heat radiation factor 0.3

$$M_E = \frac{304878}{60 \times 15 \times 4.19 \times 1.0}$$

$$= 80.8 \text{ L/min} \Rightarrow 90 \text{ L/min}$$

Therefore, total required cooling water capacity for each pump is

$$Q_{CWP} = \Sigma Q$$

$$= 120 + 10$$

$$= \underline{\underline{130 \text{ L/min}}}$$ ← 冷却水ポンプ(主ポンプ用)必要容量

And then, for each generator

Q_{CWG} = 90 L/min ← 冷却水ポンプ(発電機用)必要容量

1.1.3 REQUIRED TOTAL HEAD FOR WATER COOLING WATER

For calculation, some conditions and requirements are supposed and given that,

a) LWL of Cooling Water Reserver is 3,000mm from surface on pump floor.

b) The admissible pressure for inlet of engine is from 0m to 10m or less.

d) Required total head is divided as below
Before engine, total head is borne by cooling water pump, so
after pass the engine other total head is borne by included pump of the engine.

c) Required residual head for cooling tower is about 5m

So, total required head shall be calculated for the most farther pump from Cooling Water Reserver and Cooling Towers.

(1) For cooling water pump

(1)-1 Actual Head

Ha = 15.55 − 8.1
= 7.45 m
Has = 3.5 m Suction section
Had = 3.95 m Discharge section

LWL	8.1	m
Inlet level for engine	15.55	m
Standard level of cooling water pump	11.6	m

(1)-2 Loss Head

a) Suction section

	D1
Pipe bore m	0.05
Veracity m/s	1.103
Veracity Head m	0.062

Q = 130 L/min
= 0.00217 m^3/s

1) Friction loss of discharge straight pipe

$$h1s = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.045

= 0.53 m

L = 9.5 m approx.

2) Friction loss of foot Valve

$$h2s = \zeta \times \frac{V^2}{2g}$$

ζ = 2.2

= 0.136 m

3) Minor loss

Supposed as 0.5 m

So total suction loss head is 1.166 m ⇒ hfs = 1.17 m

b) Discharge section

	D1	D2	
Pipe bore m	0.05	0.05	
Veracity m/s	1.103	1.019	
Veracity Head m	0.062	0.053	

Q1 = 130 L/min Q3
= 0.0022 m^3/s
Q2 = 120 L/min
= 0.0020 m^3/s

1) Friction loss of discharge straight pipe section D1

$$h1d = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.045

= 0.067 m

L = 1.2 m approx.

2) Friction loss of discharge straight pipe section D2

$$h2d = \lambda \times \frac{L}{D2} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D2)) x 1.5
= 0.045

= 0.239 m

L = 5 m approx.

3) Minor loss including divided flow loss

Supposed as 3.0 m

So total suction loss head is 3.306 m ⇒ hfd = 3.31 m

(1)-3 Total Head

HT = Ha + Hfs + Hfd

= 11.93 m so, required total head of cooling water pump is determined 12m or more.

(2) For included pump of the engine

(2)-1 Actual Head

Ha = 12.95 − 15.85 + 5

= 2.1 m

Outlet level for engine	15.85	m
Inlet level for cooling tower	12.95	m
Required head at inlet for cooling tower	5	m

(2)-2 Loss Head

		D1	D2	D3
Pipe bore	m	0.05	0.1	0.08
Veracity	m/s	1.103	1.294	1.104
Veracity Head	m	0.062	0.085	0.062

Q1 = 130 L/min = 0.0022 m^3/s

Q2 = 610 L/min = 0.0102 m^3/s

Q3 = 203 # L/min = 0.0056 m^3/s

1) Friction loss of discharge straight pipe section D1

$$h1 = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.045

= 0.497 m

L = 8.9 m approx.

2) Friction loss of discharge straight pipe section D2

$$h2 = \lambda \times \frac{L}{D2} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D2)) x 1.5
= 0.0375

= 0.956 m

L = 30 m approx.

3) Friction loss of discharge straight pipe section D3

$$h3 = \lambda \times \frac{L}{D3} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D2)) x 1.5
= 0.03938

= 0.092 m

L = 3 m approx.

4) Minor loss

Supposed as 2.0 m

So total discharge loss head is 3.545 m ⇒ hfd = 3.55 m

(2)-3 Total Head

HT = Ha + Hfs + Hfd

= 5.65 m ⇒ 6 m

so, required total head of included pump of the engine is determined 6m or more.

1.1.4 REQUIRED DIAMETER OF RETURN PIPE OF COOLING WATER

Actual Head is,

Ha = 10.5 − 12.8

= −2.3 m

Outlet level for cooling tower: 12.8 m

Discharge level of return pipe of cooling water on cooling water reserver: 10.5 m

Assuming that length of return pipe from cooling tower to cooling water reserver is 30 m.

Q = 610 L/min ← クーリングタワー水量

= 0.0102 m^3/s

Diameter of return pipe of cooling water from cooling tower is determined that total loss head depending on pipe bore must be less than absolute value of actual head from cooling tower to reserver.

Pipe bore m	0.1	0.125	0.15	
Veracity m/s	1.294	0.828	0.575	
Veracity Head m	0.085	0.035	0.017	
λ	0.0375	0.0360	0.0350	
Friction loss m	0.96	0.30	0.12	
Minor loss m	1.5	1.5	1.5	including velocity head
total loss head m	2.46	1.80	1.62	

Therefore, required pipe bore is 125A or more.

1.2 換気容量計算書 (QUIAPO)

1.2.1 THE OBJECTS FOR CALCULATION OF VENTILATION CAPACITY

The equipments and points for calculation are listed below.

Equipments	Points to Check
MAIN ENGINE	Quantity heat due to radiation Amount of combustible air
REDUCTION GEAR	Quantity heat due to radiation
GENERATOR AND ENGINE	Quantity heat due to radiation Amount of combustible air
EXHAUST PIPE AND SILENCER FOR MAIN ENGINE	Quantity heat due to radiation
EXHAUST PIPE AND SILENCER FOR GENERATOR	Quantity heat due to radiation

1.2.2 CALCULATION OF VENTILATION CAPACITY

The ventilation capacity shall be depended on the sum of amount of combustible air by engines and cooling air for quantity heat due to radiation by equipments.

$V = V1 + V2$

In this case, we shall disregard heat radiations from panels. Because cubicle switchgear and DC panels are in electric electric room that has individual ventilation, and control panels shall release less amount of heat in engine room.

(1) Required ventilation capacity of cooling air for quantity heat due to radiations

$$V1 = \frac{\Sigma Q}{60 \times C_p \times (t_n - t_0) \times \rho}$$

V1 ;	Required ventilation capacity		m^3/min
ρ ;	Air density (at 920hPa, 37℃, 50%RH)	1.024	kg/m^3
C_p ;	Specific heat capacity at constant pressure of air	0.00028	kWh/kg/℃
t_n ;	Room air temperature	37	℃
t_o ;	Outdoor temperature	27	℃

1-1) Quantity heat due to radiation from Main Engine: Q_E

$Q_E = n \times P_E \times B_E \times H_U \times f$

n ;	Quantity	4	sets
P_E ;	Output of main engines	96	kW
B_E ;	Fuel consumption	0.34	kg/kW/h
H_U ;	Net calorific value of diesel oil	11.92	kWh/kg
f ;	Radiation ratio of diesel engine (up to 1,000min^{-1})	0.025	

$Q_E = 4 \times 96 \times 0.34 \times 11.92 \times 0.025$

$= 38.91$ kw

1-2) Quantity heat due to radiation from Reduction Gear: Q_G

$Q_E = n \times \alpha \times P_E \times (1 - \eta_G)$

n ;	Quantity	4	sets
α ;	Coefficient of radiation of reduction gear	0.15	
η_c ;	Transmission efficiency	0.96	

$Q_E = 4 \times 0 \times 96 \times (1 - 0.96)$

$= 2.30$ kw

1-3) Quantity heat due to radiation from Engine for Generator: Q_{GE}

$$Q_E = n \times P_{GE} \times B_{GE} \times H_{UGE} \times f_{GE}$$

n	; Quantity	2	sets
P_{GE}	; Output of engine	70	kW
B_{GE}	; Fuel consumption	0.34	kg/kW/h
H_{UGE}	; Net calorific value of diesel oil	11.92	kWh/kg
f_{GE}	; Radiation ratio of diesel engine (over 1,000min^{-1})	0.04	

$Q_E = 2 \times 70 \times 0.34 \times 11.92 \times 0.04$

$= \boxed{22.7}$ kw

1-4) Quantity heat due to radiation from Generator: Q_{Gn}

$$Q_E = n \times P_{Gn} \times PF_{Gn} \times (1 - \eta_{Gn})$$

n	; Quantity	2	sets
P_{Gn}	; Output of generator	75	kVA
PF_{Gn}	; Power factor of generator	0.8	
η_{Gn}	; Efficiency of generator	0.857	

$Q_E = 2 \times 75 \times 0.8 \times (1 - 0.86)$

$= \boxed{17.16}$ kw

1-5) Quantity heat due to radiation from Exhaust pipe of Main Engine : Q_{EXE}

$$Q_{EXE} = n \times \frac{2\pi \times (\theta_r - \theta_o)}{\frac{1}{\lambda} \times \ln \frac{d_1}{d_0} + \frac{2}{\alpha \times d_1}} \times L / 1000$$

n	; Quantity	4	sets
θ_r	; Exhaust gas temperature (non turbo charger)	400	℃
θ_t	; Room air temperature	37	℃
λ	; Thermal conductivity of a thermal insulation material	0.0688	W/m/℃
d_1	; Outside diameter of a thermal insulation material	0.25	m
d_0	; Inside diameter of a thermal insulation material	0.15	m
α	; Surface coefficient of heat transfer of a thermal insulation material	10	W/m^2/℃
L	; Length of a thermal insulation material	13	m

$$Q_{EXE} = 4 \times \frac{2\pi \times (400 - 37)}{\frac{1}{0.0688} \times \ln \frac{0.25}{0.15} + \frac{2}{10 \times 0.25}} \times 13 / 1000$$

$= \boxed{14.42}$ kw

1-6) Quantity heat due to radiation from Exhaust pipe of Generator Engine : Q_{EXGE}

$$Q_{EXE} = n \times \frac{2\pi \times (\theta_r - \theta_o)}{\frac{1}{\lambda} \times \ln \frac{d_1}{d_0} + \frac{2}{\alpha \times d_1}} \times L / 1000$$

n	; Quantity	2	sets
θ_r	; Exhaust gas temperature (non turbo charger)	400	℃
θ_t	; Room air temperature	37	℃
λ	; Thermal conductivity of a thermal insulation material	0.0688	W/m/℃
d_1	; Outside diameter of a thermal insulation material	0.18	m
d_0	; Inside diameter of a thermal insulation material	0.08	m

α ; Surface coefficient of heat transfer of a thermal insulation material : 10 $W/m^2/℃$

L ; Length of a thermal insulation material : 9 m

$$Q_{EXE} = 2 \times \frac{2\pi \times (400 - 37)}{\frac{1}{0.0688} \times \ln\frac{0.18}{0.08} + \frac{2}{10 \times 0.18}} \times 9 / 1000$$

$$= 3.18 \text{ kw}$$

Therefore, V1 is

$$V1 = \frac{\Sigma Q}{60 \times C_p \times (t_n - t_0)}$$

$$= \frac{38.91 + 2.30 + 22.70 + 17.16 + 14.42 + 3.18}{60 \times 0.00028 \times (37 - 27) \times 1.024}$$

$$= 573.6 \text{ m}^3/\text{min} \Rightarrow \underline{574 \text{ m}^3/\text{min}}$$

(2) Required ventilation capacity of combustible air

$$V2 = \Sigma V_S$$

2-1) Amount of combustible air of Main Engine : V_{SE}

$$V_{SE} = n \times \frac{A0 \times B_E \times P_E \times K}{60} \times \frac{P_0}{P_N} \times \frac{t_N + 273}{273}$$

n ; Quantity : 4 sets

A_0 ; Amount of theoretical combustion air for diesel oil : 11.2 m^3/kg (NTP)

B_E ; Fuel consumption : 0.34 kg/kW/h

P_E ; Output of main engine : 96 kW

K ; Excess air ratio : Diesel Engine : 2.5

P_0 ; Standard atmospheric pressure : 1013 hPa

P_N ; Atmospheric pressure at running condition : 920 hPa

t_N ; Atmospheric temperature at running condition : 37 ℃

$$V_{SE} = 4 \times \frac{11.2 \times 0.34 \times 96 \times 2.5}{60} \times \frac{1013}{920} \times \frac{37 + 273}{273}$$

$$= 76.18 \text{ m}^3/\text{min}$$

2-2) Amount of combustible air of Generator Engine : V_{SGE}

$$V_{SGE} = n \times \frac{A0 \times B_E \times P_E \times K}{60} \times \frac{P_0}{P_N} \times \frac{t_N + 273}{273}$$

n ; Quantity : 2 sets

A_0 ; Amount of theoretical combustion air for diesel oil : 11.2 m^3/kg (NTP)

B_E ; Fuel consumption : 0.34 kg/kW/h

P_E ; Output of main engine (supposed) : 70 kW

K ; Excess air ratio : Diesel Engine : 2.5

P_0 ; Standard atmospheric pressure : 1013 hPa

P_N ; Atmospheric pressure at running condition : 920 hPa

t_N ; Atmospheric temperature at running condition : 37 ℃

$$V_{SGE} = 2 \times \frac{11.2 \times 0.34 \times 70 \times 2.5}{60} \times \frac{1013}{920} \times \frac{37 + 273}{273}$$

$$= \boxed{27.77}\ m^3/min$$

Therefore, V1 is

$$V2 = V_{SE} + V_{SGE}$$

$$= 76.18 + 27.77$$

$$= 104\ m^3/min \quad \Rightarrow \quad \underline{104\ m^3/min}$$

Thereby total ventilation capacity is fixed below,

$$V = V1 + V2$$

$$= 574 + 104$$

$$= \underline{678\ m^3/min} \leftarrow \text{必要換気容量}$$

$$= \underline{11.3\ m^3/s}$$

$$= \underline{40{,}680\ m^3/h}$$

2. アビレス・サンパロック排水機場補助機器仕様計算書 (AVILES)

2.1 ポンプ及び減速機動力仕様計算書

2.1.1 SPECIFICATIONS OF MAIN DRAINAGE PUMP in AVILES PUMPING STATION

2.1.1.1 OPERATING CONDITIONS

(1) CAPACITY

Aviles Pumping Station is expected to reinforce the total discharge capacity as $3m^3/s$ without increasing the number of installation of main drainage pumps.

a. Total Capacity Q_T = 17.1 m^3/s (The present condition is 14.1 m^3/s)

b. Unit Capacity Q = 4.275 m^3/s (The present condition is 3.525 m^3/s)

(2) Water Level

	Pasig River	Estro	Note
High Water Level	10.5	13.2	
Low Water Level	10.3	10.5	

(3) Actual Head

Design actual head is calculated following

Ha = Ham x C

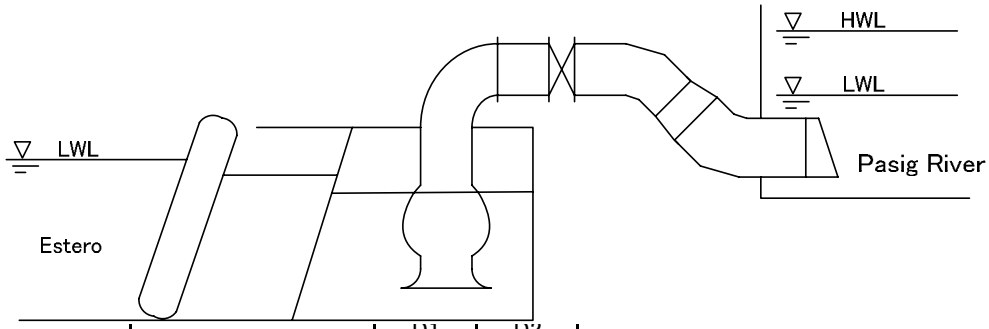
Ham : Maximum actual head = 13.2 − 10.3
= 2.9

C : Correction factor = 0.8

Ha = 2.9 x 0.8

= 2.32 m

(4) Loss Head



		D1	D2
Pipe bore	m	1.2	1.5
Verocity	m/s	3.780	2.419
Verocity Head	m	0.729	0.299

1) Friction loss of discharge straight pipe

$$h1 = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.03063

= 0.124 m

L = 6.68 m

2) Friction loss of bend pipe (60 deg D=1.2m)

$$h2 = \zeta \times \frac{V^2}{2g}$$

ζ = 0.268

= 0.195 m

3) Friction loss of conical pipe (D=1.2m → D=1.5m)

$$h3 = \zeta \times \frac{V^2}{2g} \qquad \zeta = 0.19$$

$$= 0.139 \text{ m}$$

4) Friction loss of bend pipe (60 deg D=1.5m)

$$h4 = \zeta \times \frac{V^2}{2g} \qquad \zeta = 0.268$$

$$= 0.080 \text{ m}$$

5) Friction loss of discharge straight pipe

$$h5 = \lambda \times \frac{L}{D2} \times \frac{V^2}{2g} \qquad \lambda = (0.02 + 1 / (2000 \times D2)) \times 1.5$$

$$= 0.0305$$

$$= 0.023 \text{ m} \qquad L = 3.8 \text{ m}$$

6) Friction loss of flap valve

$$h6 = \zeta \times \frac{V^2}{2g} \qquad \zeta = 0.5$$

$$= 0.150 \text{ m}$$

7) Velocity head loss

$$h7 = \zeta \times \frac{V^2}{2g} \qquad \zeta = 1$$

$$= 0.299 \text{ m}$$

8) Screen loss

$$h7 = 0.300 \text{ m}$$

Therefore, total loss head is determinded below.

$$h = 0.124 + 0.195 + 0.139 + 0.080 + 0.023 + 0.150 + 0.299 + 0.300$$

$$= 1.31 \text{ m}$$

(5) Pump Head

$$H = Ha + h$$

$$= 3.63 \text{ m} \Rightarrow \underline{\mathbf{3.6\ m}}$$

2.1.1.2 Determination of diesel engine output

Diesel engin output for main pump driving is fixed below.

$$P = 0.163 \times \frac{Q \times H}{\eta_P \times \eta_G} \times \alpha$$

$$= 0.163 \times \frac{Q \times H}{\eta_P \times \eta_G} \times \alpha$$

$$= 0.163 \times \frac{256.5 \times 3.6}{0.8 \times 0.96} \times 1.25$$

$$= 245 \Rightarrow \underline{\mathbf{\textit{240\ kW}}}$$ ← ポンプ動力

Q : Pump capacity (m^3/min)
H : Pump head (m)
η_P : Pump efficiency (%)
η_G : Reduction gear efficiency (%)
α : Allowance output

2.1.2 SPECIFICATIONS OF REDUCTION GEAR EQUIPMENT

Transmission capacity of reduction gear equipmt that driving main drainag pump is fixed with the following formula.

$$\text{Transmission capacity} = \frac{\text{Driver output} \times \text{Load factor}}{\text{Life factor}}$$

Load factor of reduction gear to driver and coupling type

Driver \ Input side coupling	Fulid coupling	High elastic coupring	Flexible coupring
Mortor or turbin	1.00	1.00	1.00
Diesel engine with 6 cylinders or more	1.00	1.10	1.25
Diesel engine with less than 6 cylinders	1.10	1.25	1.50

Life factor of reduction gear to running time

Total running time (h)	12,000 or less	25,000 or less	35,000 or less	50,000 or less	75,000 or less
Annual running time (h)	300 or less	600 or less	900 or less	1,200 or less	2,500 or less
Life factor	1.33	1.00	0.87	0.82	0.72
			↑ applied		

So,

$$\text{Transmission capacity} = \frac{240 \times 1.10}{0.87}$$

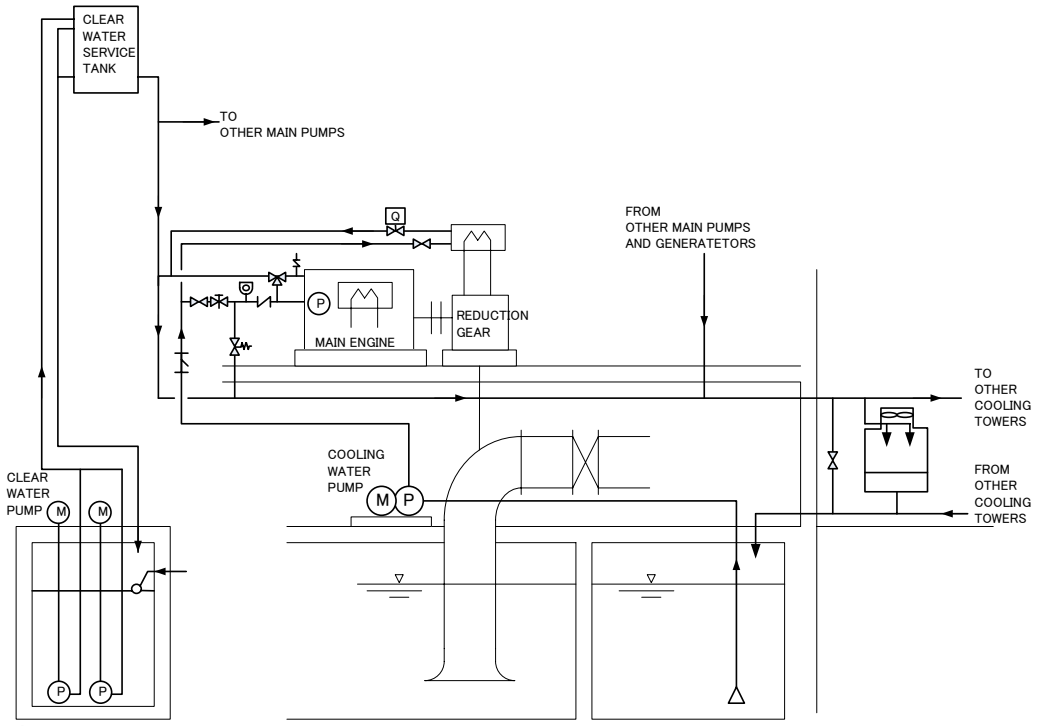
$$= 303.4 \text{ kW} \Rightarrow \underline{\textit{305 kW}}$$

減速機軸動力

2.2 冷却機器仕様計算書 (AVILES)

2.2.1 FLOW SHEET OF COOLING WATER EQUIPMENTS

The cooling water system is composed from following equipments described in flow sheet and equipments of heat resource are shown in table.



Heat resource

	Output (kW)	Sets
Main engine	240	4
Reduction gear	240	4
Generator engine	70	2

2.2.2 REQUIRED COOLING WATER CAPACITY

Total required cooling water capacity is determined by following equation.

$$Q_{CW} = \Sigma Q$$

(1) Required cooling water capacity for Main Engine

Required water capacity is calculated below.

$$Q_{ME} = \frac{Q_c}{60 \times \Delta T \times C \times \gamma}$$

Q_{ME} : Required water capacity for main engine (L/min)

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

Q_c : Quantity of heat of Main Engine (kJ/h)

$$Q_c = P_E \times B_E \times H_U \times \tau$$

P_E : Engine output 240 kW

B_E : Fuel consumption 0.27 kg/kW/h

H_U : Net calorific value of diesel oil 42700 MJ/kg

τ : Heat radiation factor 0.3

$$Q_{ME} = \frac{830{,}088}{60 \times 15 \times 4.19 \times 1.0}$$

= 220.1 L/min ⇒ 230 L/min

(2) Required cooling water capacity for Reduction Gear

Required water capacity is calculated below.

$$Q_G = \frac{60 \times P_E \times (1 - \eta)}{\Delta T \times C \times \gamma}$$

Q_G : Required water capacity for reduction gear (L/min)

P_E : Engine output 240 kW

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

η : Efficiency of reduction gear 0.96

$$Q_G = \frac{60 \times 240 \times (1 - 0.96)}{15 \times 4.19 \times 1.0}$$

= 9.2 L/min ⇒ 10 L/min

(3) Required cooling water capacity for Generator Engine

Required water capacity is calculated below.

$$Q_{GE} = \frac{Q_c}{60 \times \Delta T \times C \times \gamma}$$

Q_{GE} : Required water capacity for generator engine (L/min)

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

Q_c : Quantity of heat of Main Engine (kJ/h)

$Q_c = P_E \times B_E \times H_U \times \tau$

P_E : Engine output 70 kW

B_E : Fuel consumption 0.34 kg/kW/h

H_U : Net calorific value of diesel oil 42700 MJ/kg

τ : Heat radiation factor 0.3

$$Q_{ME} = \frac{304878}{60 \times 15 \times 4.19 \times 1.0}$$

= 80.8 L/min ⇒ 90 L/min

Therefore, total required cooling water capacity for each pump is

$Q_{CWP} = \Sigma Q$

= 230 + 10

= 240 L/min ← 冷却水ポンプ(主ポンプ用)必要容量

And then, for each generator

Q_{CWG} = 90 L/min ← 冷却水ポンプ(発電機用)必要容量

2.2.3 REQUIRED TOTAL HEAD FOR WATER COOLING WATER

For calculation, some conditions and requirements are supposed and given that,

a) LWL of Cooling Water Reserver is 3,000mm from surface on pump floor.

b) The admissible pressure at inlet of engine is from 0m to 10m or less.

d) Required total head is divided as below
Before engine, total head is borne by cooling water pump, so
after pass the engine other total head is borne by included pump of the engine.

c) Required residual head for cooling tower is about 5m

So, total required head shall be calculated for the most farther pump from Cooling Water Reserver and Cooling Towers.

(1) For cooling water pump

(1)-1 Actual Head

Ha = 15.75 − 8
= 7.75 m
Has = 3.5 m Suction section
Had = 4.25 m Discharge section

LWL	8	m
Inlet level for engine	15.75	m
Standard level of cooling water pump	11.5	m

(1)-2 Loss Head

a) Suction section

	D1
Pipe bore m	0.065
Veracity m/s	1.205
Veracity Head m	0.074

Q = 240 L/min
= 0.00400 m^3/s

1) Friction loss of discharge straight pipe

$$h1s = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.04154

= 0.591 m

L = 12.5 m approx.

2) Friction loss of foot Valve

$$h2s = \zeta \times \frac{V^2}{2g}$$

ζ = 2.2

= 0.163 m

3) Minor loss

Supposed as 0.5 m

So total suction loss head is 1.254 m ⇒ hfs = 1.25 m

b) Discharge section

	D1	D2	
Pipe bore m	0.05	0.05	
Veracity m/s	2.037	1.952	
Veracity Head m	0.212	0.194	

Q1 = 240 L/min Q3
= 0.0040 m^3/s
Q2 = 230 L/min
= 0.0038 m^3/s

1) Friction loss of discharge straight pipe section D1

$$h1d = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.045

= 0.229 m

L = 1.2 m approx.

2) Friction loss of discharge straight pipe section D2

$$h2d = \lambda \times \frac{L}{D2} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D2)) x 1.5
= 0.045

= 0.698 m

L = 4 m approx.

3) Minor loss including divided flow loss

Supposed as 2.0 m

So total suction loss head is 2.927 m ⇒ hfd = 2.93 m

(1)-3 Total Head

HT = Ha + Hfs + Hfd

= 11.93 m so, required total head of cooling water pump is determined 12m or more.

(2) For included pump of the engine

(2)-1 Actual Head

Ha = 12.85 − 15.75 + 5

= 2.095 m

Outlet level for engine	15.75	m
Inlet level for cooling tower	12.85	m
Required head at inlet for cooling tower	5	m

(2)-2 Loss Head

		D1	D2	D3
Pipe bore	m	0.065	0.125	0.1
Veracity	m/s	1.205	1.426	0.707
Veracity Head	m	0.074	0.104	0.026

Q1 = 240 L/min = 0.0040 m^3/s
Q3 = 525 L/min = 0.0056 m^3/s
Q2 = 1050 L/min = 0.0175 m^3/s

1) Friction loss of discharge straight pipe section D1

$$h1 = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D1)) x 1.5
= 0.04154

= 0.629 m

L = 13.3 m approx.

2) Friction loss of discharge straight pipe section D2

$$h2 = \lambda \times \frac{L}{D2} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D2)) x 1.5
= 0.036

= 0.785 m

L = 26.2 m approx.

3) Friction loss of discharge straight pipe section D3

$$h3 = \lambda \times \frac{L}{D3} \times \frac{V^2}{2g}$$

λ = (0.02 + 1 / (2000 x D2)) x 1.5
= 0.0375

= 0.029 m

L = 3 m approx.

4) Minor loss

Supposed as 3.0 m

So total discharge loss head is 4.443 m ⇒ hfd = 4.44 m

(2)-3 Total Head

HT = Ha + Hfs + Hfd

= 6.535 m ⇒ 7 m

so, required total head of included pump of the engine is determined 7m or more.

2.2.4 REQUIRED DIAMETER OF RETURN PIPE OF COOLING WATER

Actual Head is,

Ha = 10.5 − 12.85

= −2.35 m

Outlet level for cooling tower: 12.85 m

Discharge level of return pipe of cooling water on cooling water reserver: 10.5 m

Assuming that length of return pipe from cooling tower to cooling water reserver is 30 m.

Q = 1050 L/min ← クーリングタワー水量

= 0.0175 m^3/s

Diameter of return pipe of cooling water from cooling tower is determined that total loss head depending on pipe bore must be less than absolute value of actual head from cooling tower to reserver.

Pipe bore m	0.1	0.125	0.15	
Veracity m/s	2.228	1.426	0.990	
Veracity Head m	0.253	0.104	0.05	
λ	0.0375	0.0360	0.0350	
Friction loss m	2.85	0.90	0.35	
Minor loss m	1.5	1.5	1.5	including velocity head
total loss head m	4.35	2.40	1.85	

Therefore, required pipe bore is 150A or more.

2.3 換気容量計算書 (AVILES)

2.3.1 THE OBJECTS FOR CALCULATION OF VENTILATION CAPACITY

The equipments and check points for calculation are listed below.

Equipments	Points to Check
MAIN ENGINE	Quantity heat due to radiation Amount of combustible air
REDUCTION GEAR	Quantity heat due to radiation
GENERATOR AND ENGINE	Quantity heat due to radiation Amount of combustible air
EXHAUST PIPE AND SILENCER FOR MAIN ENGINE	Quantity heat due to radiation
EXHAUST PIPE AND SILENCER FOR GENERATOR	Quantity heat due to radiation

2.3.2 CALCULATION OF VENTILATION CAPACITY

The ventilation capacity shall be depended on the sum of amount of combustible air by engines and cooling air for quantity heat due to radiation by equipments.

$V = V1 + V2$

In this case, we shall disregard heat radiations from panels. Because cubicle switchgear and DC panels are in electric electric room that has individual ventilation, and control panels shall release less amount of heat in engine room.

(1) Required ventilation capacity of cooling air for quantity heat due to radiations

$$V1 = \frac{\Sigma Q}{60 \times C_p \times (t_n - t_0) \times \rho}$$

V1	;	Required ventilation capacity		m^3/min
ρ	;	Air density (at 920hPa, 37℃, 50%RH)	1.024	kg/m^3
C_p	;	Specific heat capacity at constant pressure of air	0.00028	kWh/kg/℃
t_n	;	Room air temperature	37	℃
t_o	;	Outdoor temperature	27	℃

1-1) Quantity heat due to radiation from Main Engine: Q_E

$Q_E = n \times P_E \times B_E \times H_U \times f$

n	;	Quantity	4	sets
P_E	;	Output of main engines	240	kW
B_E	;	Fuel consumption	0.27	kg/kW/h
H_U	;	Net calorific value of diesel oil	11.92	kWh/kg
f	;	Radiation ratio of diesel engine (up to 1,000min^{-1})	0.025	

$Q_E = 4 \times 240 \times 0.27 \times 11.92 \times 0.025$

$= 77.24$ kw

1-2) Quantity heat due to radiation from Reduction Gear: Q_G

$Q_E = n \times \alpha \times P_E \times (1 - \eta_G)$

n	;	Quantity	4	sets
α	;	Coefficient of radiation of reduction gear	0.15	
η_G	;	Transmission efficiency	0.96	

$Q_E = 4 \times 0 \times 240 \times (1 - 0.96)$

$= 5.76$ kw

1-3) Quantity heat due to radiation from Engine for Generator: Q_{GE}

$$Q_E = n \times P_{GE} \times B_{GE} \times H_{UGE} \times f_{GE}$$

n	; Quantity	2	sets
P_{GE}	; Output of engine	70.8	kW
B_{GE}	; Fuel consumption	0.34	kg/kW/h
H_{UGE}	; Net calorific value of diesel oil	11.92	kWh/kg
f_{GE}	; Radiation ratio of diesel engine (over 1,000min^{-1})	0.04	

$Q_E = 2 \times 70.8 \times 0.34 \times 11.92 \times 0.04$

$= 22.96$ kw

1-4) Quantity heat due to radiation from Generator: Q_{Gn}

$$Q_E = n \times P_{Gn} \times PF_{Gn} \times (1 - \eta_{Gn})$$

n	; Quantity	2	sets
P_{Gn}	; Output of generator	75	kVA
PF_{Gn}	; Power factor of generator	0.8	
η_{Gn}	; Efficiency of generator	0.857	

$Q_E = 2 \times 75 \times 0.8 \times (1 - 0.86)$

$= 17.16$ kw

1-5) Quantity heat due to radiation from Exhaust pipe of Main Engine : Q_{EXE}

$$Q_{EXE} = n \times \frac{2\pi \times (\theta_r - \theta_o)}{\frac{1}{\lambda} \times \ln \frac{d_1}{d_0} + \frac{2}{\alpha \times d_1}} \times L / 1000$$

n	; Quantity	4	sets
θ_r	; Exhaust gas temperature (with turbo charger)	375	℃
θ_t	; Room air temperature	37	℃
λ	; Thermal conductivity of a thermal insulation material	0.0688	W/m/℃
d_1	; Outside diameter of a thermal insulation material	0.25	m
d_0	; Inside diameter of a thermal insulation material	0.15	m
α	; Surface coefficient of heat transfer of a thermal insulation material	10	W/m^2/℃
L	; Length of a thermal insulation material	13	m

$$Q_{EXE} = 4 \times \frac{2\pi \times (375 - 37)}{\frac{1}{0.0688} \times \ln \frac{0.25}{0.15} + \frac{2}{10 \times 0.25}} \times 13 / 1000$$

$= 13.43$ kw

1-6) Quantity heat due to radiation from Exhaust pipe of Generator Engine : Q_{EXGE}

$$Q_{EXE} = n \times \frac{2\pi \times (\theta_r - \theta_o)}{\frac{1}{\lambda} \times \ln \frac{d_1}{d_0} + \frac{2}{\alpha \times d_1}} \times L / 1000$$

n	; Quantity	2	sets
θ_r	; Exhaust gas temperature (non turbo charger)	400	℃
θ_t	; Room air temperature	37	℃
λ	; Thermal conductivity of a thermal insulation material	0.0688	W/m/℃
d_1	; Outside diameter of a thermal insulation material	0.18	m
d_0	; Inside diameter of a thermal insulation material	0.08	m

α ; Surface coefficient of heat transfer of a thermal insulation material : 10 W/m²/℃

L ; Length of a thermal insulation material : 9 m

$$Q_{EXE} = 2 \times \frac{2\pi \times (400 - 37)}{\frac{1}{0.0688} \times \ln\frac{0.18}{0.08} + \frac{2}{10 \times 0.18}} \times 9 / 1000$$

$$= 3.18 \text{ kw}$$

Therefore, V1 is

$$V1 = \frac{\Sigma Q}{60 \times C_p \times (t_n - t_0)}$$

$$= \frac{77.24 + 5.76 + 22.96 + 17.16 + 13.43 + 3.18}{60 \times 0.00028 \times (37 - 27) \times 1.024}$$

$$= 812.2 \text{ m}^3/\text{min} \Rightarrow \underline{812 \text{ m}^3/\text{min}}$$

(2) Required ventilation capacity of combustible air

$$V2 = \Sigma V_S$$

2-1) Amount of combustible air of Main Engine : V_{SE}

$$V_{SE} = n \times \frac{A0 \times B_E \times P_E \times K}{60} \times \frac{P_0}{P_N} \times \frac{t_N + 273}{273}$$

n ; Quantity : 4 sets

A_0 ; Amount of theoretical combustion air for diesel oil : 11.2 m³/kg (NTP)

B_E ; Fuel consumption : 0.27 kg/kW/h

P_E ; Output of main engine : 240 kW

K ; Excess air ratio : Diesel Engine : 2.5

P_0 ; Standard atmospheric pressure : 1013 hPa

P_N ; Atmospheric pressure at running condition : 920 hPa

t_N ; Atmospheric temperature at running condition : 37 ℃

$$V_{SE} = 4 \times \frac{11.2 \times 0.27 \times 240 \times 2.5}{60} \times \frac{1013}{920} \times \frac{37 + 273}{273}$$

$$= 151.2 \text{ m}^3/\text{min}$$

2-2) Amount of combustible air of Generator Engine : V_{SGE}

$$V_{SGE} = n \times \frac{A0 \times B_E \times P_E \times K}{60} \times \frac{P_0}{P_N} \times \frac{t_N + 273}{273}$$

n ; Quantity : 2 sets

A_0 ; Amount of theoretical combustion air for diesel oil : 11.2 m³/kg (NTP)

B_E ; Fuel consumption : 0.34 kg/kW/h

P_E ; Output of main engine (supposed) : 70.8 kW

K ; Excess air ratio : Diesel Engine : 2.5

P_0 ; Standard atmospheric pressure : 1013 hPa

P_N ; Atmospheric pressure at running condition : 920 hPa

t_N ; Atmospheric temperature at running condition : 37 ℃

$$V_{SGE} = 2 \times \frac{11.2 \times 0.34 \times 70.8 \times 2.5}{60} \times \frac{1013}{920} \times \frac{37 + 273}{273}$$

$$= \boxed{28.09}\ m^3/min$$

Therefore, V2 is

$$V2 = V_{SE} + V_{SGE}$$
$$= 151.2 + 28.09$$
$$= 179.3\ m^3/min \quad \Rightarrow \quad \underline{\underline{179\ m^3/min}}$$

Thereby total ventilation capacity is fixed below,

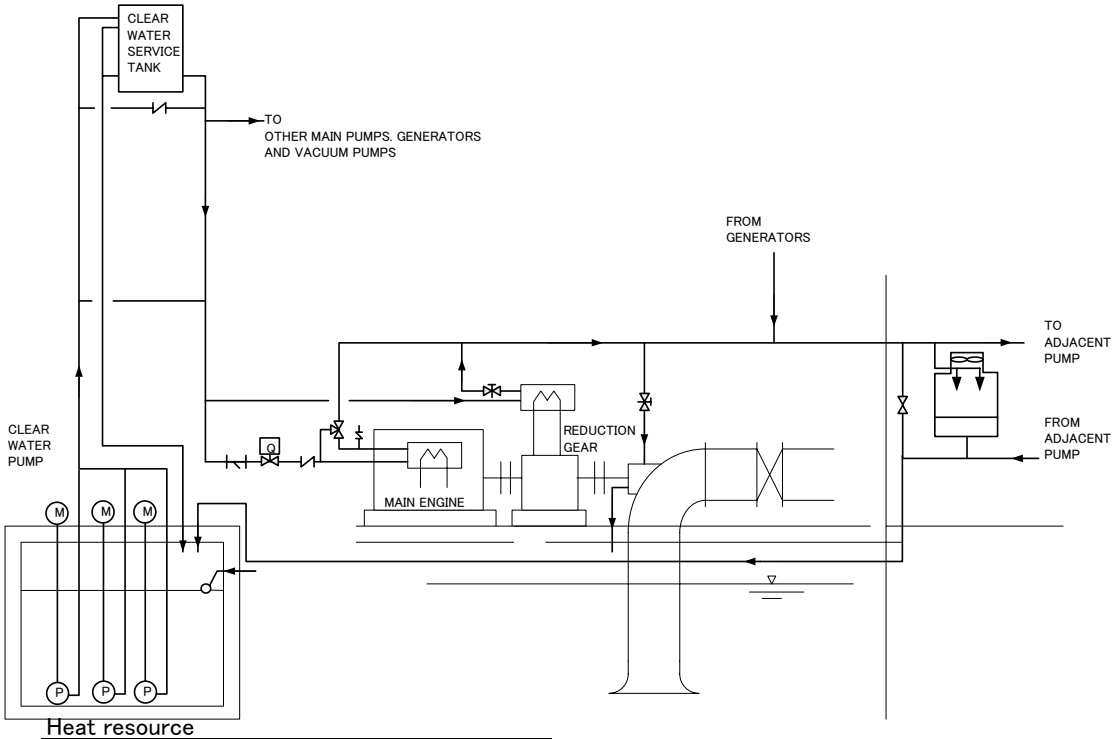
$$V = V1 + V2$$
$$= 812 + 179$$
$$= \underline{\underline{991\ m^3/min}} \leftarrow \text{必要換気容量}$$
$$= \underline{\underline{16.52\ m^3/s}}$$
$$= \underline{\underline{59{,}460\ m^3/h}}$$

3. トリパ・デ・ガリナ排水機場補助機器仕様計算書 （ TRIPA ）

3.1 冷却機器仕様計算書

3.1.1 FLOW SHEET OF COOLING WATER EQUIPMENTS

The cooling water system is composed from following equipments described in flow sheet and equipments of heat resource are shown in table.



Heat resource

	Output (kW)	Sets
Main engine	331	4
Reduction gear	331	4
Generator engine	140	2

3.1.2 REQUIRED COOLING WATER CAPACITY

Total required cooling water capacity is determined by following equation.

$$Q_{CW} = \Sigma Q$$

(1) Required cooling water capacity for Main Engine

Required water capacity is calculated below.

$$Q_{ME} = \frac{Q_c}{60 \times \Delta T \times C \times \gamma}$$

Q_{ME} : Required water capacity for main engine (L/min)

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

Q_c : Quantity of heat of Main Engine (kJ/h)

$$Q_c = P_E \times B_E \times H_U \times \tau$$

P_E : Engine output 331 kW

B_E : Fuel consumption 0.27 kg/kW/h

H_U : Net calorific value of diesel oil 42700 MJ/kg

τ : Heat radiation factor 0.3

$$Q_{ME} = \frac{1{,}144{,}830}{60 \times 15 \times 4.19 \times 1.0}$$

$$= 303.6 \text{ L/min} \Rightarrow 310 \text{ L/min}$$

(2) Required cooling water capacity for Reduction Gear

Required water capacity is calculated below.

$$Q_G = \frac{60 \times P_E \times (1 - \eta)}{\Delta T \times C \times \gamma}$$

Q_G : Required water capacity for reduction gear (L/min)

P_E : Engine output 331 kW

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

η : Efficiency of reduction gear 0.97

$$Q_G = \frac{60 \times 331 \times (1 - 0.97)}{15 \times 4.19 \times 1.0}$$

$$= 9.5 \text{ L/min} \Rightarrow 10 \text{ L/min}$$

(3) Required cooling water capacity for Generator Engine

Required water capacity is calculated below.

$$Q_{GE} = \frac{Q_c}{60 \times \Delta T \times C \times \gamma}$$

Q_{GE} : Required water capacity for generator engine (L/min)

ΔT : Temperature difference of cooling water between input and output
= 15 ℃

C : Specific heat of water
= 4.19 kJ/(kg*℃) = 4.19 kW*s/(kg*℃)

γ : Mass of water = 1.0

Q_c : Quantity of heat of Main Engine (kJ/h)

$$Q_c = P_E \times B_E \times H_U \times \tau$$

P_E : Engine output 140 kW

B_E : Fuel consumption 0.3 kg/kW/h

H_U : Net calorific value of diesel oil 42700 MJ/kg

τ : Heat radiation factor 0.3

$$M_E = \frac{538020}{60 \times 15 \times 4.19 \times 1.0}$$

$$= 142.7 \text{ L/min} \Rightarrow 150 \text{ L/min}$$

Therefore, total required cooling water capacity for total pumps is

$$Q_{CWP} = \Sigma Q$$

$$= (310 + 10) \times 8$$

$$= 2560 \text{ L/min}$$

And then, for generator

Q_{CWG} = 150 L/min ← 冷却水ポンプ必要容量

So, total required cooling water capacity is 2710 L/min ← クーリングタワー水量

Existing fresh water pumps are three sets, so capacity for each pump is 677.5 ⇒ 700 L/min

3.1.3 REQUIRED TOTAL HEAD FOR WATER COOLING WATER

For calculation, some conditions and requirements are supposed and given that,

a) LWL of Cooling Water Reserver is EL. 8.60 .

b) The admissible pressure for inlet of engine is from 0m to 10m or less.

d) Required total head is divided as below
Before engine, total head is borne by cooling water pump, so
after pass the engine other total head is borne by included pump of the engine.

c) Required residual head for cooling tower is about 5m

So, total required head shall be calculated for the most farther pump from Cooling Water Reserver and Cooling Towers.

(1) For cooling water pump

(1)-1 Actual Head

Ha = 14.2 − 8.6
= 5.6 m

LWL	8.6	m
Inlet level for main engine	14.2	m

(1)-2 Loss Head

a) Discharge section

	D1	D2	D3	D4	D5	D6	D7
Pipe bore m	0.15	0.15	0.15	0.125	0.125	0.125	0.065
Veracity m/s	1.952	1.811	1.509	1.738	1.304	0.869	1.607
Veracity Head m	0.194	0.167	0.116	0.154	0.087	0.039	0.1320

Q1 = 2070 L/min = 0.0345 m^3/s
Q2 = 1920 L/min = 0.0320 m^3/s
Q3 = 1600 L/min = 0.0267 m^3/s
Q4 = 1280 L/min = 0.0213 m^3/s
Q5 = 960 L/min = 0.0160 m^3/s
Q6 = 640 L/min = 0.0107 m^3/s
Q7 = 320 L/min = 0.0053 m^3/s

1) Friction loss of discharge straight pipe section D1

$$h1d = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D1)) \times 1.5 = 0.035$

= 0.023 m

L = 0.5 m

2) Friction loss of discharge straight pipe section D2

$$h2d = \lambda \times \frac{L}{D2} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D2)) \times 1.5 = 0.035$

= 0.857 m

L = 22 m

3) Friction loss of discharge straight pipe section D3

$$h3d = \lambda \times \frac{L}{D3} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D3)) \times 1.5 = 0.035$

= 0.162 m

L = 6 m

4) Friction loss of discharge straight pipe section D4

$$h4d = \lambda \times \frac{L}{D4} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D4)) \times 1.5$

$= 0.036$

$= 0.266$ m

$L = 6$ m

5) Friction loss of discharge straight pipe section D5

$$h5d = \lambda \times \frac{L}{D5} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D5)) \times 1.5$

$= 0.036$

$= 0.15$ m

$L = 6$ m

6) Friction loss of discharge straight pipe section D6

$$h6d = \lambda \times \frac{L}{D6} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D6)) \times 1.5$

$= 0.036$

$= 0.067$ m

$L = 6$ m

7) Friction loss of discharge straight pipe section D6

$$h7d = \lambda \times \frac{L}{D7} \times \frac{V^2}{2g}$$

$\lambda = (0.02 + 1 / (2000 \times D7)) \times 1.5$

$= 0.04154$

$= 0.506$ m

$L = 6$ m

3) Minor loss

Supposed as 5.0 m

So total discharge loss head is 7.031 m ⇒ hfd = 7.03 m

(1)-3 Total Head

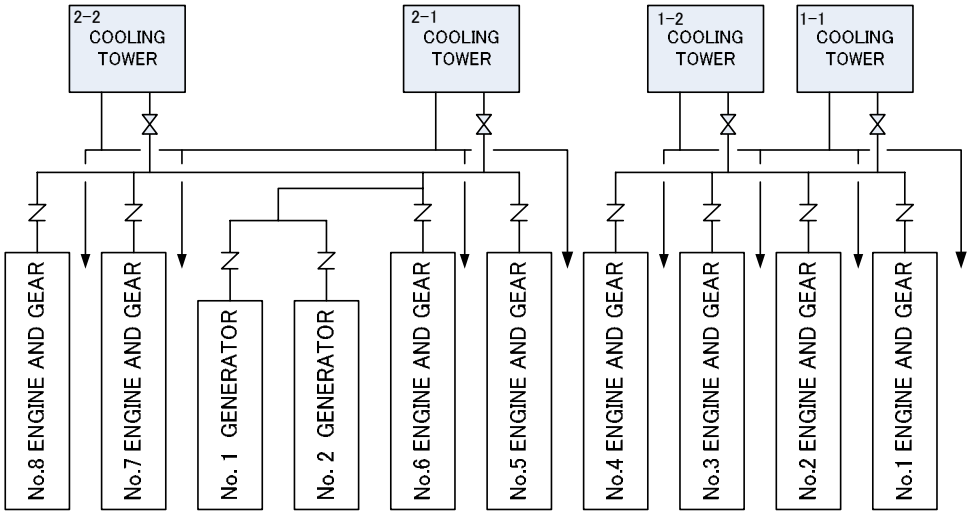
HT = Ha + Hfd

= 12.63 m

so, required total head of included pump of the engine is determined 13m or more.

(2) For included pump of the engine for No.6 pump

Total loss head is caldulated for the piping with the most water capacity.
The new group of cooling water's flow is described below.



(2)-1 Actual Head

Ha = 15.1 − 15.85 + 5

= 4.25 m

Outlet level for engine 15.85 m

Inlet level for cooling tower 15.1 m

Required head at inlet for cooling tower 5 m

(2)-2 Loss Head

		D1	D2	D3
Pipe bore	m	0.065	0.065	0.1
Veracity	m/s	1.607	2.361	0.707
Veracity Head	m	0.132	0.284	0.026

Q1 = 320 L/min = 0.0053 m^3/s Q3 = 715 L/min = 0.0056 m^3/s

Q2 = 470 L/min = 0.0078 m^3/s

1) Friction loss of discharge straight pipe section D1

$$h1 = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

= 0.759 m

λ = (0.02 + 1 / (2000 x D1)) x 1.5 = 0.04154

L = 9 m approx.

2) Friction loss of discharge straight pipe section D2

$$h2 = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

= 0.907 m

λ = (0.02 + 1 / (2000 x D2)) x 1.5 = 0.04154

L = 5 m approx.

3) Friction loss of discharge straight pipe section D3

$$h3 = \lambda \times \frac{L}{D1} \times \frac{V^2}{2g}$$

= 0.244 m

λ = (0.02 + 1 / (2000 x D2)) x 1.5 = 0.0375

L = 25 m approx.

4) Minor loss

Supposed as 2.0 m

So total discharge loss head is 3.910 m ⇒ hfd = 3.91 m

(2)-3 Total Head

HT = Ha + Hfs + Hfd

= 8.16 m ⇒ 9 m

so, required total head of included pump of the engine is determined 8m or more.

3.1.4 REQUIRED DIAMETER OF RETURN PIPE OF COOLING WATER

Actual Head is,

Ha = 11 − 13.41

= −2.41 m

Outlet level for cooling tower 13.41 m

Discharge level of return pipe of cooling water on cooling water reserver 11 m

Assuming that length of return pipe from cooling tower to cooling water reserver is 16 m.

Q = 790 L/min for No.6 pump

= 0.0132 m^3/s

Diameter of return pipe of cooling water is determined that total loss head depending on pipe bore must be less than absolute value of actual head

Pipe bore	m	0.1	0.125	0.15	
Veracity	m/s	1.676	1.073	0.745	
Veracity Head	m	0.143	0.059	0.028	
λ		0.0375	0.0360	0.0350	
Friction loss	m	0.86	0.27	0.10	
Minor loss	m	1.5	1.5	1.5	including velocity head
total loss head	m	2.36	1.77	1.60	

Therefore, required pipe bore is 100A or more.

3.2 換気容量計算書 (TRIPA)

3.2.1 THE OBJECTS FOR CALCULATION OF VENTILATION CAPACITY

The equipments and points for calculation are listed below.

Equipments	Points to Check
MAIN ENGINE	Quantity heat due to radiation Amount of combustible air
REDUCTION GEAR	Quantity heat due to radiation
GENERATOR AND ENGINE	Quantity heat due to radiation Amount of combustible air
EXHAUST PIPE AND SILENCER FOR MAIN ENGINE	Quantity heat due to radiation
EXHAUST PIPE AND SILENCER FOR GENERATOR	Quantity heat due to radiation

3.2.2 CALCULATION OF VENTILATION CAPACITY

The ventilation capacity shall be depended on the sum of amount of combustible air by engines and cooling air for quantity heat due to radiation by equipments.

$V = V1 + V2$

In this case, we shall disregard heat radiations from panels. Because cubicle switchgear and DC panels are in electric room that has individual ventilation, and control panels shall release less amount of heat in engine room.

(1) Required ventilation capacity of cooling air for quantity heat due to radiations

$$V1 = \frac{\Sigma Q}{60 \times C_p \times (t_n - t_0) \times \rho}$$

V1 ;	Required ventilation capacity		m^3/min
ρ ;	Air density (at 920hPa, 37℃, 50%RH)	1.024	kg/m^3
C_p ;	Specific heat capacity at constant pressure of air	0.00028	kWh/kg/℃
t_n ;	Room air temperature	37	℃
t_o ;	Outdoor temperature	27	℃

1-1) Quantity heat due to radiation from Main Engine: Q_E

$Q_E = n \times P_E \times B_E \times H_U \times f$

n ;	Quantity	8	sets
P_E ;	Output of main engines	324	kW
B_E ;	Fuel consumption	0.27	kg/kW/h
H_U ;	Net calorific value of diesel oil	11.92	kWh/kg
f ;	Radiation ratio of diesel engine (up to 1,000min^{-1})	0.025	

$Q_E = 8 \times 324 \times 0.27 \times 11.92 \times 0.025$

$= 208.6$ kw

1-2) Quantity heat due to radiation from Reduction Gear: Q_G

$Q_E = n \times \alpha \times P_E \times (1 - \eta_G)$

n ;	Quantity	8	sets
α ;	Coefficient of radiation of reduction gear	0.15	
η_G ;	Transmission efficiency	0.96	

$Q_E = 8 \times 0 \times 324 \times (1 - 0.96)$

$= 15.55$ kw

1-3) Quantity heat due to radiation from Engine for Generator: Q_{GE}

$$Q_E = n \times P_{GE} \times B_{GE} \times H_{UGE} \times f_{GE}$$

n	; Quantity	2	sets
P_{GE}	; Output of engine	140	kW
B_{GE}	; Fuel consumption	0.3	kg/kW/h
H_{UGE}	; Net calorific value of diesel oil	11.92	kWh/kg
f_{GE}	; Radiation ratio of diesel engine (over 1,000min^{-1})	0.04	

$Q_E = 2 \times 140 \times 0.3 \times 11.92 \times 0.04$

$= \boxed{40.05}$ kw

1-4) Quantity heat due to radiation from Generator: Q_{Gn}

$$Q_E = n \times P_{Gn} \times PF_{Gn} \times (1 - \eta_{Gn})$$

n	; Quantity	2	sets
P_{Gn}	; Output of generator	150	kVA
PF_{Gn}	; Power factor of generator	0.8	
η_{Gn}	; Efficiency of generator	0.857	

$Q_E = 2 \times 150 \times 0.8 \times (1 - 0.86)$

$= \boxed{34.32}$ kw

1-5) Quantity heat due to radiation from Exhaust pipe of Main Engine : Q_{EXE}

$$Q_{EXE} = n \times \frac{2\pi \times (\theta_r - \theta_o)}{\frac{1}{\lambda} \times \ln \frac{d_1}{d_0} + \frac{2}{\alpha \times d_1}} \times L / 1000$$

n	; Quantity	8	sets
θ_r	; Exhaust gas temperature (with turbo charger)	375	℃
θ_t	; Room air temperature	37	℃
λ	; Thermal conductivity of a thermal insulation material	0.0688	W/m/℃
d_1	; Outside diameter of a thermal insulation material	0.25	m
d_0	; Inside diameter of a thermal insulation material	0.15	m
α	; Surface coefficient of heat transfer of a thermal insulation material	10	W/m^2/℃
L	; Length of a thermal insulation material	13	m

$$Q_{EXE} = 8 \times \frac{2\pi \times (375 - 37)}{\frac{1}{0.0688} \times \ln \frac{0.25}{0.15} + \frac{2}{10 \times 0.25}} \times 13 / 1000$$

$= \boxed{26.85}$ kw

1-6) Quantity heat due to radiation from Exhaust pipe of Generator Engine : Q_{EXGE}

$$Q_{EXE} = n \times \frac{2\pi \times (\theta_r - \theta_o)}{\frac{1}{\lambda} \times \ln \frac{d_1}{d_0} + \frac{2}{\alpha \times d_1}} \times L / 1000$$

n	; Quantity	2	sets
θ_r	; Exhaust gas temperature (with turbo charger)	375	℃
θ_t	; Room air temperature	37	℃
λ	; Thermal conductivity of a thermal insulation material	0.0688	W/m/℃
d_1	; Outside diameter of a thermal insulation material	0.18	m
d_0	; Inside diameter of a thermal insulation material	0.08	m

α ; Surface coefficient of heat transfer of a thermal insulation material : 10 W/m²/℃

L ; Length of a thermal insulation material : 9 m

$$Q_{EXE} = 2 \times \frac{2\pi \times (375 - 37)}{\frac{1}{0.0688} \times \ln\frac{0.18}{0.08} + \frac{2}{10 \times 0.18}} \times 9 / 1000$$

$$= 2.96 \text{ kw}$$

Therefore, V1 is

$$V1 = \frac{\Sigma Q}{60 \times C_p \times (t_n - t_0)}$$

$$= \frac{208.6 + 15.55 + 40.05 + 34.32 + 26.85 + 2.96}{60 \times 0.00028 \times (37 - 27) \times 1.024}$$

$$= 1908 \text{ m}^3/\text{min} \Rightarrow \underline{1908 \text{ m}^3/\text{min}}$$

(2) Required ventilation capacity of combustible air

$$V2 = \Sigma V_S$$

2-1) Amount of combustible air of Main Engine : V_{SE}

$$V_{SE} = n \times \frac{A0 \times B_E \times P_E \times K}{60} \times \frac{P_0}{P_N} \times \frac{t_N + 273}{273}$$

n ; Quantity : 8 sets

A_0 ; Amount of theoretical combustion air for diesel oil : 11.2 m³/kg (NTP)

B_E ; Fuel consumption : 0.27 kg/kW/h

P_E ; Output of main engine : 324 kW

K ; Excess air ratio : Diesel Engine : 2.5

P_0 ; Standard atmospheric pressure : 1013 hPa

P_N ; Atmospheric pressure at running condition : 920 hPa

t_N ; Atmospheric temperature at running condition : 37 ℃

$$V_{SE} = 8 \times \frac{11.2 \times 0.27 \times 324 \times 2.5}{60} \times \frac{1013}{920} \times \frac{37 + 273}{273}$$

$$= 408.3 \text{ m}^3/\text{min}$$

2-2) Amount of combustible air of Generator Engine : V_{SGE}

$$V_{SGE} = n \times \frac{A0 \times B_E \times P_E \times K}{60} \times \frac{P_0}{P_N} \times \frac{t_N + 273}{273}$$

n ; Quantity : 2 sets

A_0 ; Amount of theoretical combustion air for diesel oil : 11.2 m³/kg (NTP)

B_E ; Fuel consumption : 0.3 kg/kW/h

P_E ; Output of main engine (supposed) : 140 kW

K ; Excess air ratio : Diesel Engine : 2.5

P_0 ; Standard atmospheric pressure : 1013 hPa

P_N ; Atmospheric pressure at running condition : 920 hPa

t_N ; Atmospheric temperature at running condition : 37 ℃

$$V_{SGE} = 2 \times \frac{11.2 \times 0.3 \times 140 \times 2.5}{60} \times \frac{1013}{920} \times \frac{37 + 273}{273}$$

$$= \boxed{49.01}\ m^3/min$$

Therefore, V1 is

$$V2 = V_{SE} + V_{SGE}$$
$$= 408.3 + 49.01$$
$$= 457.4\ m^3/min \quad \Rightarrow \quad \underline{457\ m^3/min}$$

Thereby total ventilation capacity is fixed below,

$$V = V1 + V2$$
$$= 1908 + 457$$
$$= \underline{2365\ m^3/min} \quad \leftarrow \text{必要換気容量}$$
$$= \underline{39.42\ m^3/s}$$
$$= \underline{141{,}900\ m^3/h}$$

G　　機材維持管理修繕費用内訳表

機材維持管理修繕費用内訳表

金額単位：Peso

項　　目	維持修繕費率 (%)	耐用年数 (year)	年間 維持修繕費率 (%/year)	キアポ		アビレス・サンパロック		トリパ・デ・ガリナ		備　　考
				機材金額	年間 維持修繕費	機材金額	年間 維持修繕費	機材金額	年間 維持修繕費	
主ポンプ	30	30	1.00	52,900,000	529,000	69,900,000	699,000	149,000,000	1,490,000	機材費は想定値
主エンジン・減速機	45	27	1.67	36,818,000	614,861	61,700,000	1,030,390	144,855,000	2,419,079	採用FOB価格
自動除塵機	50	20	2.50	27,800,000	695,000	19,900,000	497,500	61,900,000	1,547,500	機材費は想定値
補機類	30	18	1.67	1,761,000	29,409	1,879,000	31,379	4,830,000	80,661	採用FOB価格
クーリングタワー	50	18	2.78	1,006,000	27,967	1,259,000	35,000	4,268,000	118,650	採用FOB価格
受配電盤・操作盤	45	18	2.50	6,388,000	159,700	6,704,000	167,600	9,602,000	240,050	採用FOB価格
合　　計					2,055,936		2,460,870		5,895,940	