APPENDIX-15

ENVIRONMENTAL EDUCATION MATERIALS

Contents

APPENDIX 15

ENVIRONMENTAL EDUCATION MATERIALS

15.1 PREVIOUS PHASE OF THE PROGRAM

15.1.1 GENERAL

The objectives of the overall program are to publicize the problem of pollution, create awareness, and educate people on the causes of pollution, and to promote participation in the campaign to clean up Havana Bay.

These objectives were only partially fulfilled due to staffing problems (resignation) at GTE, and the relatively short time period over which the program was to be implemented, the program was not completed by the end of the Master Plan phase, and not all of the education material was produced.

15.1.2 EDUCATION MATERIAL

The target groups selected for the program were as follows:

- Children & Youth (Primary and Secondary schools in the Study Area)
- INRH (DPRH, EAH, all Havana Water and Sewerage Enterprises)
- Citizens in general(In the City of Havana)

Accordingly, the education material produced for this program was as follows:

- Leaflets for children and youth (5,000 copies)
- Leaflets for adults (5,000 copies)
- Posters for general use (5,000 copies)
- A video for national TV and schools (2 No. Originals + 30 copies)
- A six part radio program (3 No. CD's + 10 copies each)
- General Information (JICA Study Team) (25 copies)
- General Information (CIGEA) (1 Diskette)

15.1.3 PROGRAM IMPLEMENTATION

(1) Program for Children and Youth

During the Master Plan phase only four schools were included in what may now be considered as a pilot phase. The report prepared by the facilitator of this short program was encouraging enough for GTE to continue the program in other schools. There were sufficient leaflets and posters for at least another 200 schools, however, GTE were not able to make much progress from March to June 2003 again due to staffing problems (Sickness).

Some progress was made in that GTE now have an agreement with MINED to introduce the environmental problems of the bay into the schools curriculum.

(2) Program for INRH Agencies

There was no progress on this program.

(3) Program for Citizens in general

At the end of the Master Plan phase, both the video and the six part radio program became available. The video was screened on the national television educational channel, but there are no details of the number of screenings or of the impact on the population.

The contents of the three CD's for radio, with the theme of "Save of the Bay"(duration of 15 to 20 minutes each) are as follows:

- Description of Havana Bay through the years from a geographical and environmental point of view
- Introduction to objectives and principal actions of the environmental clean-up program for Havana Bay (JICA project)
- Current environmental system in Havana Bay
- Sewerage and drainage system in Havana Bay basin. (background information, current situation, problems and solutions)
- Environmental pollution and related health risks
- Environmental information and education as a tool for community participation

Broadcasting only commenced on Havana radio in September 2003, and there is as yet no information on the impact of the programs. Plans are under way to provide other radio stations in Havana with the programs.

15.2 PROGRAM EXTENSION DURING FEASIBILITY STUDY

15.2.1 EDUCATION MATERIAL

Due to time constraints mentioned earlier, not all of the educational material was produced during the Master Plan phase, hence it was decided that the Feasibility Study should include an extension to the program to allow for more material to be produced, and to include in this material, the technical findings of the Master Plan.

Accordingly, during the Feasibility Study on the Priority Project, the following additional environmental education material was prepared.

(1) Preparation of a Second Video Program

In the previous study phase, a 12 minute video program "Salvando la Esperanza" was produced to provide general information to schools and to the public on the present conditions of the water environment of Havana Bay, the pollution sources and the need for early action to improve the water environment.

As a follow up, a second video was prepared by the JICA Study Team in cooperation with the counterparts from GTE and the Cuban video professional. The brief was to introduce an outline of the Sewerage Master Plan, the contribution and limitations of the plan to the improvement of the environment of Havana Bay, as well as the activities of the study team and its counterpart staff. The video is entitled "From Vision to Reality", (A Sewerage Master Plan for Havana Bay).

This video, which lasts for about 25 minutes, is aimed at decision makers in the relevant government departments, personnel in the water supply & sewerage corporations, the environmental sector, and other international organizations who may have an interest in becoming involved in the environmental problem of Havana Bay. Accordingly the video was produced with both Spanish and English commentary for use inside and outside Cuba.

(2) A Handbook for Local Communities

In response to a request from GTE, a handbook was prepared and 1,000 copies were printed for use in the program. This book was principally prepared by counterparts from GTE and INRH in cooperation with the JICA Study Team, with the title "Environmental Education and Community Participation as a way to Clean up Havana Bay"

The target groups for this book are communities and schoolchildren living in the City of Havana who wish to participate in the drive to clean up Havana Bay. It is divided into three chapters and includes information on the following:

Chapter 1 Results of the Development Study on the Improvement of Sewerage and Drainage Systems for Havana Bay

This chapter describes the fundamental objectives of the Master Plan Study, gives the actual situation on water resources within the bay basin, including results of water quality analysis, and the monitoring system, together with basic information on Environmental Law and Regulations. It concludes with a general description of the Master Plan.

Chapter 2 Environmental Education: A Tool for all to help Clean up the Bay

This chapter presents the results of the earlier program for schools and INRH. It describes the methodology adopted at the workshops; the issues that were raised, and the results and conclusions from the exercise. It is particularly useful as a reference point for the new facilitators to continue the implementation of the education program.

Chapter 3 Environmental Action and Community Participation: A Proposal for Havana Bay

This chapter gives a definition of environmental action and its importance, and details the results which may be obtained by communities and groups using participation as a means of promoting the protection of the environment. Examples are given of types and mechanisms of participative action, and a proposed model participative method is given.

The chapter concludes with a cartoon like sketch section which gives a graphic illustration of how communities can obtain information on environmental problems, form groups and hold meetings to address their problems. This is particularly useful for community participation.

(3) A Training Handbook for the Staff of Wastewater Services etc.

Again, in response to a request from GTE, a handbook was prepared and 1,000 copies were printed for use by ministry personnel, the staff of water and sewerage corporations, industrial workers and all those involved in the clean up of Havana Bay. This book was principally prepared by counterparts from GTE and INRH in cooperation with the JICA Study Team, with the title "Rescue Havana Bay: Environmental Information for Environmental Action." It is divided into three chapters and includes information on the following:

Chapter 1 Current Environmental Situation in the City of Havana

This chapter describes the water resources and associated pollution in the bay basin, and lists other principal environmental problems in addition to the pollution by wastewater. It proposes a strategy to minimize the problem as well as listing the tools for implementation at provincial level.

Chapter 2 Havana Bay; Environmental Problems and Solutions

This chapter presents information on the characteristics of the bay basin, the formation of GTE, and describes the principal environmental problems. These problems are not only related to pollution by wastewater, but include among other causes, solid waste, air pollution, and soil erosion.

Chapter 3 Results of the Development Study on the Improvement of Sewerage and Drainage Systems for Havana Bay

This chapter is a repeat of chapter 1 of the Community handbook describing the fundamental objectives of the study, and concluding with a general description of the Master Plan.

15.2.2 Training Seminar

On completion of the video and the two handbooks, a one day seminar was held to present the new educational material to the decision makers and to hold a workshop with the participants to discuss the teaching material, the methodology and analysis systems and to propose a plan of action. The decision makers and invited guests were from the following institutions and organizations:

- JICA (1)
- JICA Study Team (5)
- MINED (National & Provincial)(2)
- University of Havana (1)
- MINAG (1)
- DCITMA (1)
- DPRH (1)
- GTE (3)
- GEF (Almendares Project) (1)
- Mass Organizations (1)
- Provincial Directorate (Solid Waste)(1)
- NGO ProNaturaleza (1)

The participants invited numbered fifty two and had been pre-selected to become facilitators for the implementation program. However, not all of them attended the seminar: the following list details the attendance:

- INRH (0 of 1)
- DPRH (1 of 1)
- Water supply and Sewerage Corporations (3 of 3)
- CITMA (Municipal Level) (4 of 10)
- MINED (Municipal methodologists) (8 of 10)
- Schools (from four municipalities) (5 of 8)
- Community Organizations (4 of 10)
- Industry (from ten of the major polluters)(10 of 10)

The morning session comprised of a presentation of the objectives of the seminar, the premier of the video, and presentation of the contents of the handbooks (including a book produced largely by MINED, to be financed by GTE, for use by a range of personnel in the teaching profession explaining the strategies and methodology to be used in environmental education).

These presentations created a lot of comments from the participants who were clearly impressed with the educational material produced and soon to become available.

The afternoon session commenced with a practical presentation of the methodology to be used by the facilitators and this again drew a lively response with many useful implementation systems being suggested. In the subsequent workshop session, the future facilitators were divided into four groups (Communities/CITMA; INRH; Education; and Industry). The current environmental education system was analyzed using the DAFO system as given below:

Debilidades (Weaknesses)
Amenazas (Threats)
Fortalezas (Strengths)
Oportunidades(Opportunities)

Each group then drew up an action plan for the future implementation of the environmental education program and these were presented to the total gathering. These proposals will be considered by GTE when drawing up a final implementation schedule for the environmental education program.

15.3 EXECUTION OF ENVIRONMENTAL EDUCATION PROGRAM

The JICA Study Team task during the Feasibility Study was essentially to provide further material to enable GTE to continue with and expand the implementation of the program in communities and schools, and within the water supply & sewerage sector and other related institutions and agencies.

Accordingly extensive discussions were held with the relevant staff members of GTE on the use of the educational material and the framework of the proposed program which now needs to be developed in detail. The most important issue is the capacity of GTE to initiate the program in terms of both human and financial resources. The issued discussed were as follows:

15.3.1 GTE CAPACITY FOR PROGRAM IMPLEMENTATION

As regards human resources, the program will be implemented through the Vice Directorate of Planning, Information & Development, utilizing the services of the Environmental Management Vice Directorate for the industry program as it already has strong links with industry. Staff availability from the two departments is as follows:

- Vice Director Part time to formulate the program and control implementation
- 1 No. Specialist Full time on the schools and community program
- 1 No. Specialist Part time on the INRH, industries etc. program
- 4 No. specialists (Environmental & Management); part time on industry program

The main task of the GTE team is to develop an overall environmental program, as none exists at present. This will be followed by liaison with school specialists and the training of other facilitators for the community, INRH, water supply & sewerage corporations, industry etc. programs, with the provision of the educational material developed during this Study. The finances available may be between US$ 10-20,000 per annum depending on other commitments.

15.3.2 SCHOOLS PROGRAM

The schools program is relatively straight forward in that every municipality has a ministry of education methodologist who is a specialist in environmental education. In addition all schools have trained teaching staff capable of running the program utilizing the “special interests groups” which already exist in all schools for subjects such as culture, history etc. Under the agreement between GTE and MINED the environmental problems of the bay have already been introduced in eight schools in each of the ten municipalities and “special interest groups” have been formed.

GTE only need to liaise with the ten methodologists (most of whom attended the seminar), explain the general principles of the program, agree a time schedule, and provide the education material this being the first video, the poster, leaflet, and the book. There are about 177 primary, 58 secondary, and 26 special schools in the bay basin, hence, the need to plan an implementation schedule.

15.3.3 COMMUNITY PROGRAM

The communities lack trained facilitators at this point in time, and a program for training of trainers is required. It will be necessary for GTE to run training seminars and workshops in the first instance before the community programs can commence. The Vice Director of Planning, Information & Development is a specialist with communities and the VICE Director must have the time for this section of the program.

In the 10 municipalities in the bay basin there are 42 Popular Councils and numerous existing organizations such as the CDR, League of Cuban Women, local and international NGO's in the 115 districts, all of which can be used to develop community participation in this environmental program.

GTE will have to provide a substantial input into this part of the program as well as making available the videos, poster, leaflets, and books.

15.3.4 INRH, WASTEWATER SERVICES ETC PROGRAM

This program is intended to cover a diverse range of agencies in addition to INRH, including the water supply and sewerage corporations, agencies of CITMA, and industry etc. As per the community program, a program for training of trainers will be required to develop core groups of facilitators within each group of agencies.

GTE will again be required to run training seminars and workshops before these programs can commence. For the industries section of the program, GTE can call upon the services of its specials in the Vice Directorate of Environmental Management who have regular contact with the industries who are polluters, to assist with the training of trainers.

15.4 CONCLUSION AND RECOMMENDATIONS

Whilst it is known that GTE has plans for an extensive sophisticated Environmental Center, it will take time to secure the necessary funding and develop the complex. The implementation of this program should commence immediately.

Program development and implementation is a challenging and demanding task, and GTE have limited resources. For example, due to the resignation of one staff member, nothing was achieved on the program from October to December 2002. The replacement appointee then fell sick and the program effectively came to a halt for a period of about two months during July and August 2003.

There is only one person who is available on a full time basis and it is recommended that a second specialist be employed to ensure rapid program development and concurrent implementation in the various sectors involved in this program. In addition, implementation will require appropriate financial resources for the necessary seminars and workshops, and transport etc. to control the program.

Should the human and/or financial resources be found inadequate when the implementation program is produced, then GTE may consider seeking the required resources from international donor agencies. JICA have already committed a large amount of finance to provide educational material and it is essential that this material be put to good use with the rapid introduction and implementation of the program envisaged.

It is recommended that CIGEA be involved in the program for citizens to ensure that the television and radio programs are properly coordinated through the Mass Organizations and Organization of Journalists (see Figure 8.1, National Environmental Educational System in the Master Plan section of this report).

APPENDIX-16

DRAINAGE SYSTEM IMPROVEMENT PROPOSALS

Contents

Figures:

Tables:

A16.1 INTRODUCTION

Supporting information on the analysis of existing drainage system and improvement proposals are provided in this appendix.

A16.2 ANALYSIS OF RAINFALL DATA

Tables 16.1 shows the daily rainfall data for Casablanca Meteorological Station for probability of 1% (1 in 100 year), 5% (1 in 20 year), 10% (1 in 10 year) and 20% (1 in 5 year) which are used to obtain constants in “Talbot Equation” using specific coefficients method. TableA16.2 shows calculated and adopted constants and the calculated rainfall intensity using Talbot Equation.

A16.3 EXISTING DRAINAGE SYSTEM

Figure A16.1 shows the tributary areas of existing drainage system consisting of four major drainage system namely Arroyo Matadero, Agua Dulce, Pastrana and Lawton. Tables 16.3 shows the area of sub-tributary areas for each of the drainage system.

Figure A16.3 and Figure A16.4 show the record of profiles for Dren Matadero and Dren Agua Dulce which are used together with data in the existing drainage system map to estimate their capacities. For Lawton and Pastrana, invert elevations could not be obtained and their slope is assumed based on the ground elevation.

Table A16.4 shows unit tributary discharge for 10-year return period using Rational Method.

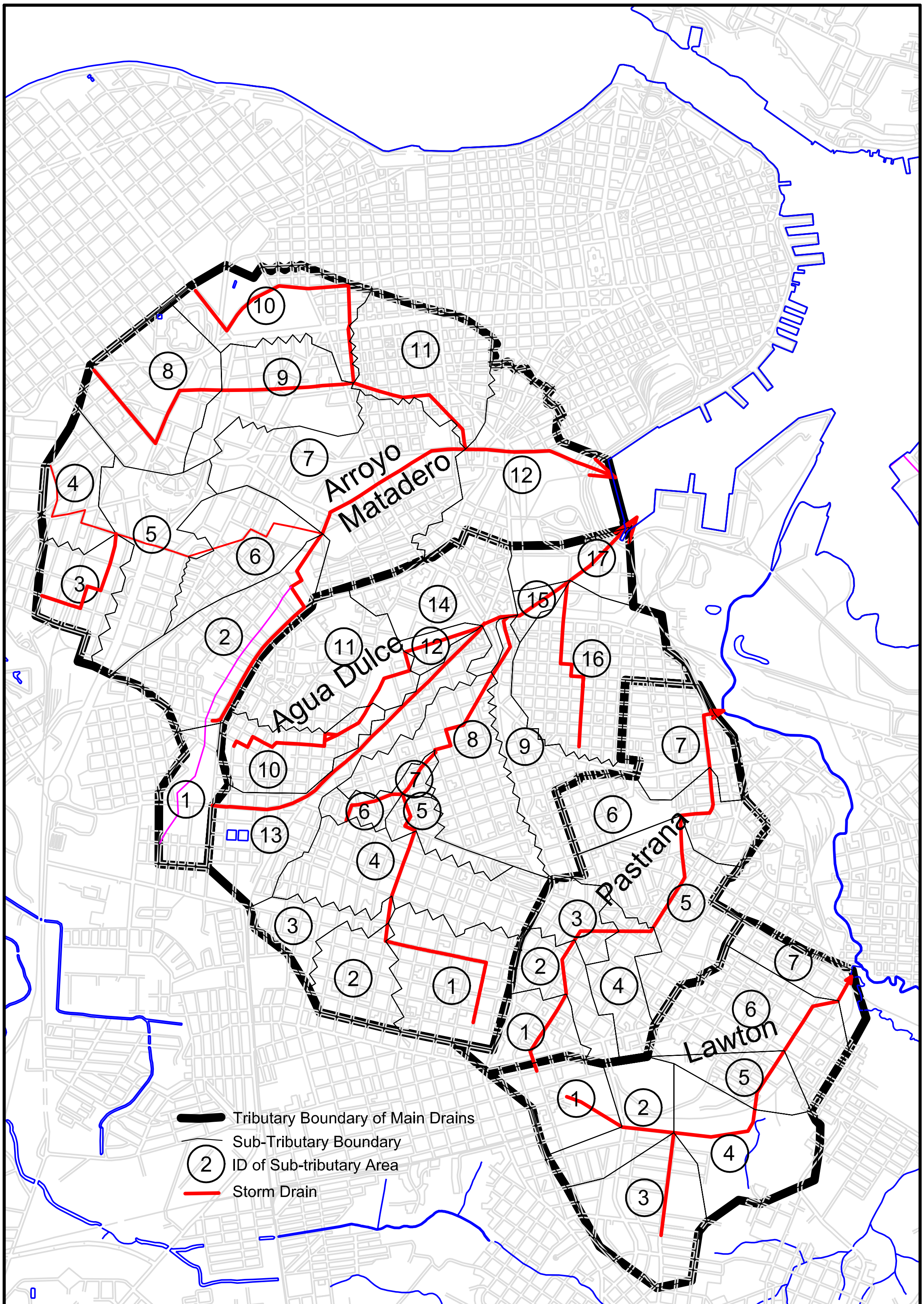
Table 16.5 through 16.8 show the estimation of capacity of major drains compared with the required design capacity for a storm of 10-year return period. For Drain Matadero, rational coefficient of 0.6 is used considering the highly urbanized nature of this area. For the other drains, rational coefficient of 0.5 is used.

Figure A16.4 shows the schematic layout of Dren Matadero and Table A16.9 shows the input data to the StormCAD program (Haestad Methods) for analysis. It is recommended that the similar input data be prepared for the other drains as well by obtaining field data in the future.

A16.4 IMPROVEMENT PLANS

A proposal for the improvement of Dren Matadero is shown on a drawing titled “Proyecto de Drenaje Pluvial para Evitar Inundaciones en la Zona del Ponton y Zonas Aledannas parte de los Municipios Cerro, Centro Habana, Habana Vieja y Plaza, Direccion Provincial de Acueducto, Alcantarillado, Fosas y Drenaje Pluvial”. In that drawing, a by-pass starting from Nueva del Pilar downstream of the Pontón area is proposed to convey approximately 80 m^3/s of stormwater flow (or in other words a drain with equivalent capacity to existing Matadero Drain) as shown in Figure A16.5.

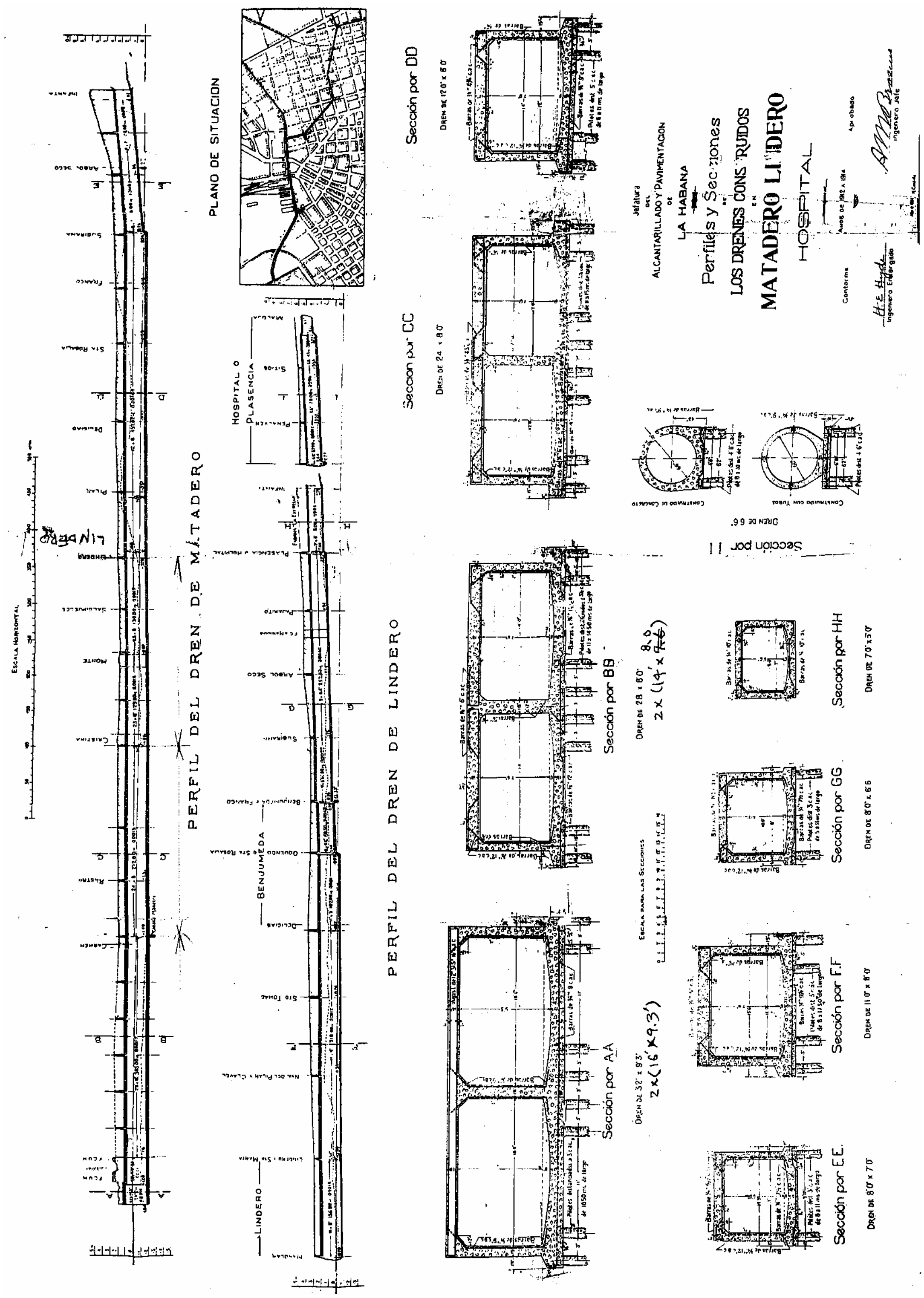
However, discharge capacity of Dren Matadero is affected by the bay water level since the invert level is below mean sea level. Therefore, provision of stormwater retention ponds is recommended to that of construction of the by-pass pipe proposed. Since the required volume and the area of stormwater retention ponds are very high (more than 100,000 m^3) it will be difficult to obtain necessary land for that purpose and providing retention ponds at several locations will be necessary. One example is of this is the construction of a stormwater retention pond in the baseball and track field of José María Pérez Social Club with a capacity of 16,000 m^3 (at a level of 2.86 m) following the severe flooding occurred in Pontón area on October14, 1999, due to Hurricane Irene.



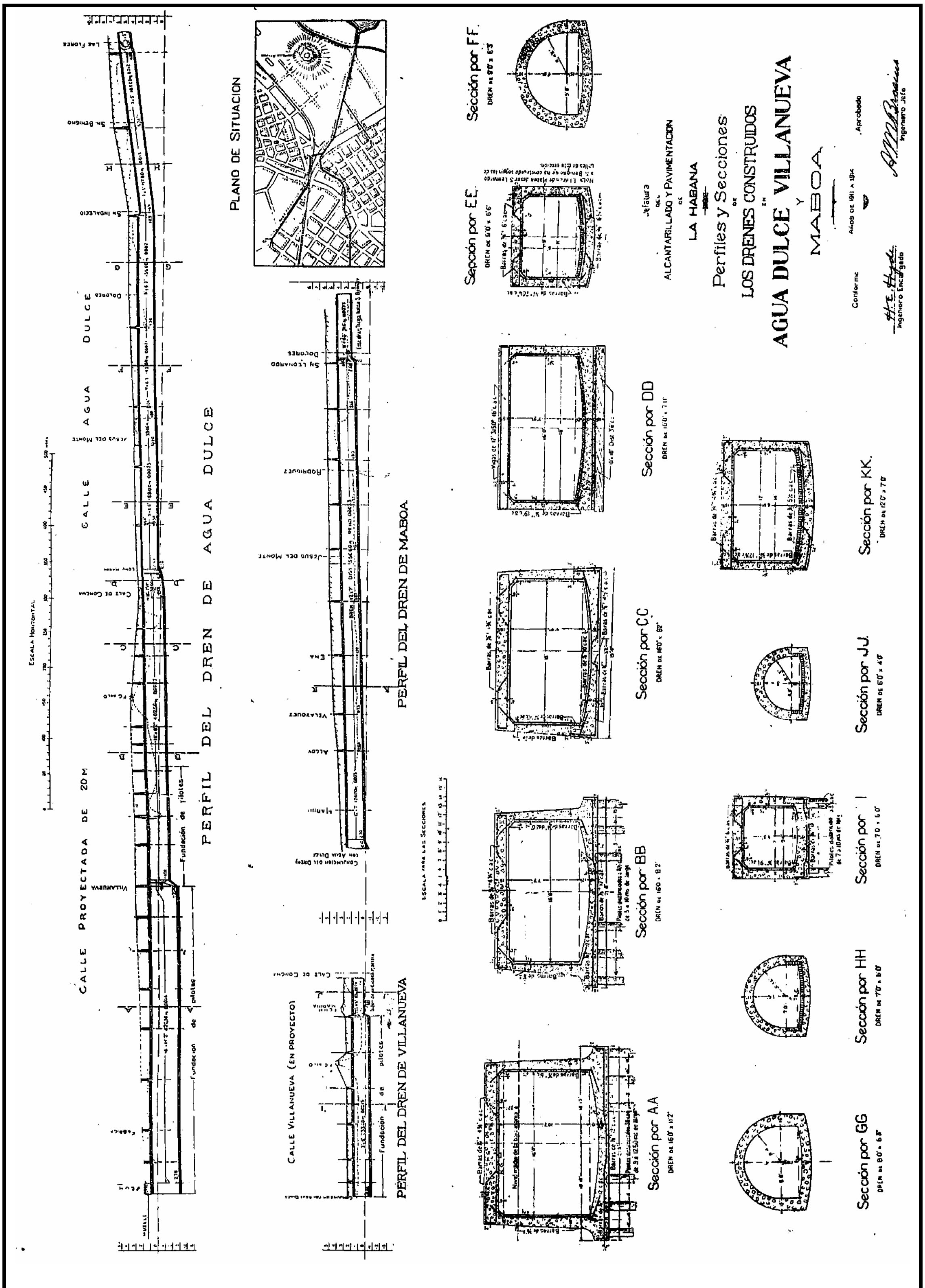
THE DEVELOPMENT STUDY OF THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

JAPAN INTERNATIONAL COOPERATION AGENCY

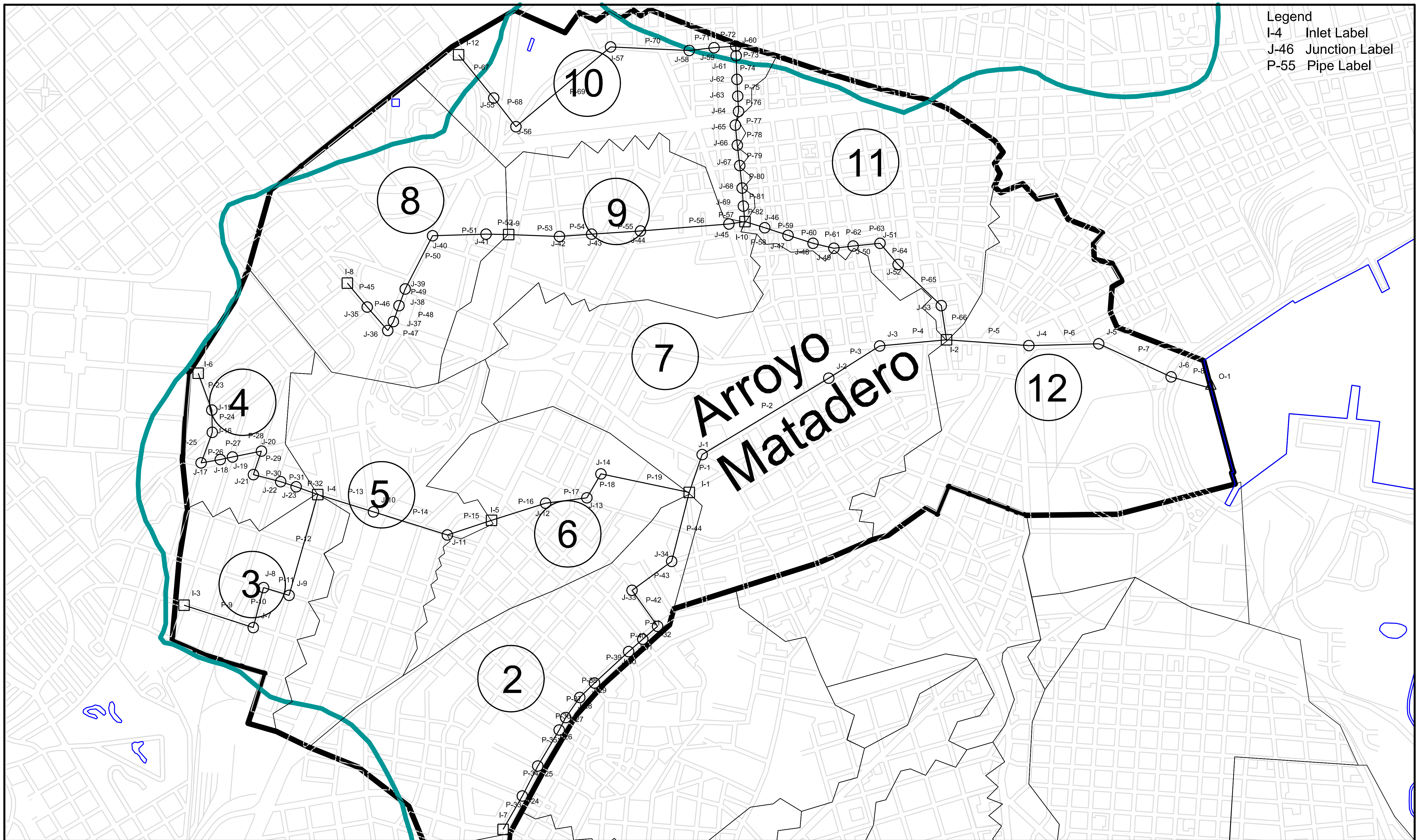
Figure A16.1
Tributary Areas of Existing Drainage System



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure A16.2 Record of the Profile of Dren Arroyo Matadero
JAPAN INTERNATIONAL COOPERATION AGENCY	



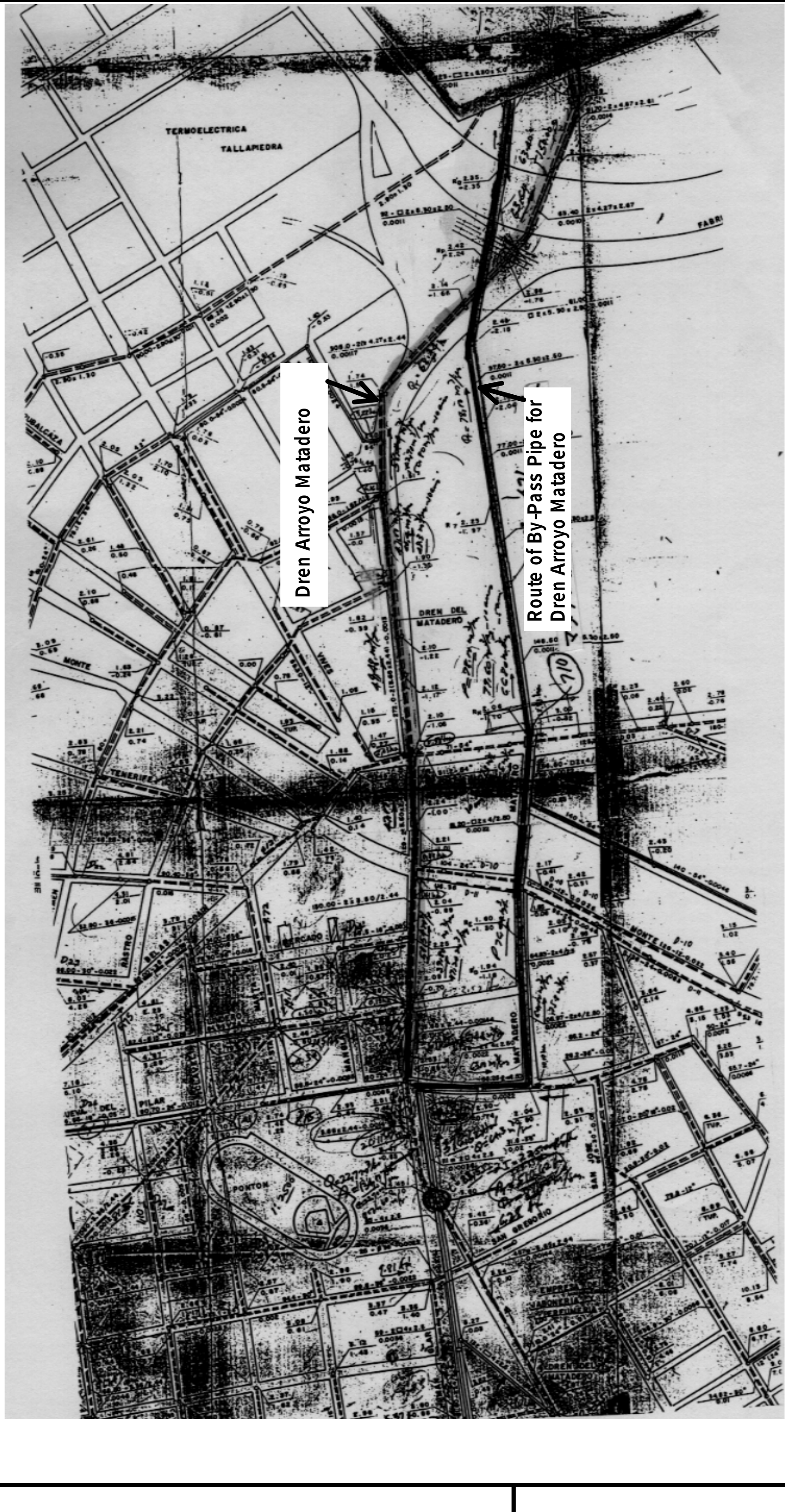
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure A16.3 Record of the Profile of Dren Agua Dulce
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE DEVELOPMENT STUDY OF THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure A16.4
Schematic Layout of Dren Matadero Used for Evaluation



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure A16.5
Previous Proposal for Improvement of Dren Arroyo Matadero

Table A16.1 Daily Rainfall Data at Casablanca Station

probability (%)	Rainfall Duration (mm/min)										
	5	10	20	40	60	90	120	150	300	720	1440
1	4.28	3.38	2.64	2.06	1.71	1.4	1.2	1.09	0.74	0.47	0.27
5	3.4	2.79	2.09	1.58	1.3	1.06	0.89	0.81	0.51	0.28	0.15
10	3.12	2.49	1.9	1.39	1.15	0.93	0.79	0.67	0.43	0.21	0.11
20	2.72	2.23	1.71	1.24	1.02	0.79	0.67	0.54	0.35	0.16	0.086

probability (%)	Rainfall Duration (mm/60min)										
	5	10	20	40	60	90	120	150	300	720	1440
1	257	203	158	124	103	84	72	65	44	28	16
5	204	167	125	95	78	64	53	49	31	17	9
10	187	149	114	83	69	56	47	40	26	13	7
20	163	134	103	74	61	47	40	32	21	10	5

probability (%)	Rainfall Duration (mm/each・min)										
	5	10	20	40	60	90	120	150	300	720	1440
1	21	34	53	82	103	126	144	164	222	338	389
5	17	28	42	63	78	95	107	122	153	202	216
10	16	25	38	56	69	84	95	101	129	151	158
20	14	22	34	50	61	71	80	81	105	115	124

Source: ordenadas de las curvas de intensidad (mm/min) para diferentes intervalosde tiempo y periodos de retorno

Data above is analyzed by the "specific coefficients method" to obtain the constants in Talbot formula.

$$I_N = R_N \cdot {}^{10}{}_N = R_N \cdot a'/(t+b)$$
$${}^{10}{}_N = I^{10}{}_N / I^{60}{}_N$$
$$I^{60}{}_N = R_N$$
$$a' = b + 60$$
$$b = (60 - 10\,{}^{10}{}_N)/({}^{10}{}_N - 1)$$

where,

: Specific coefficient
R: 60 rainfall (mm/hr)
N: Probable year in N years

Table A16.2 Calculated Constants in Talbot Equation

Probability	$I^{10}{}_N$	$I^{60}{}_N$	$\beta^{10}{}_N$	b	b(used)	a'	numerator	denominator
1 in 20 year	167	78	2.141	33.82	34	93.82	**7300**	**t+34**
1 in 10 year	149	69	2.159	33.14	33	93.14	**6400**	**t+33**
1 in 5 year	134	61	2.197	31.77	32	91.77	**5600**	**t+32**

Calculated Rainfall Intensity (mm/hr) based on Adopted Talbot Coefficients

	10	20	30	40	50	60
1 in 20 year	166	135	114	99	87	78
1 in 10 year	149	121	102	88	77	69
1 in 5 year	133	108	90	78	68	61

Table A16.3 Tributary Areas of Existing Drainage System

Summary

Drain	Area ha
Dren Matadero	715.73
Dren Agua Dulce	673.50
Dren Pastran	262.40
Dren Lawton	293.34

Dren Matadero

Sub-tributary No.	Area ha
1	30.10
2	68.72
3	30.91
4	31.28
5	60.80
6	46.21
7	120.94
8	68.07
9	53.27
10	54.68
11	60.94
12	89.81
Sub-total	**715.73**

Dren Agua Dulce

Sub-tributary No.	Area ha
1	58.58
2	31.14
3	22.42
4	73.98
5	14.22
6	9.33
7	4.57
8	70.50
9	44.35
10	36.69
11	70.75
12	7.94
13	64.59
14	49.69
15	6.79
16	81.66
17	26.30
Sub-total	**673.50**

Dren Pastran

Sub-tributary No.	Area ha
1	25.36
2	26.65
3	19.94
4	27.43
5	69.03
6	48.01
7	45.98
Sub-total	**262.40**

Dren Lawton

Sub-tributary No.	Area ha
1	32.24
2	34.47
3	55.75
4	57.00
5	23.23
6	67.16
7	23.49
Sub-total	**293.34**

Table A16.4 Unit Tributary Discharge for 10-year Return Period

$$Q=0.002778\times C\times I\times A=0.002778\times C\times \frac{6{,}400}{T+33}\times A$$

System Flow	Rational Coefficient				
T, min	0.5	0.55	0.6	0.65	0.7
6	0.228	0.251	0.274	0.296	0.319
7	0.222	0.244	0.267	0.289	0.311
8	0.217	0.239	0.26	0.282	0.304
9	0.212	0.233	0.254	0.275	0.296
10	0.207	0.227	0.248	0.269	0.289
11	0.202	0.222	0.242	0.263	0.283
12	0.198	0.217	0.237	0.257	0.277
13	0.193	0.213	0.232	0.251	0.271
14	0.189	0.208	0.227	0.246	0.265
15	0.185	0.204	0.222	0.241	0.259
16	0.181	0.2	0.218	0.236	0.254
17	0.178	0.196	0.213	0.231	0.249
18	0.174	0.192	0.209	0.227	0.244
19	0.171	0.188	0.205	0.222	0.239
20	0.168	0.185	0.201	0.218	0.235
21	0.165	0.181	0.198	0.214	0.23
22	0.162	0.178	0.194	0.21	0.226
23	0.159	0.175	0.19	0.206	0.222
24	0.156	0.172	0.187	0.203	0.218
25	0.153	0.169	0.184	0.199	0.215
26	0.151	0.166	0.181	0.196	0.211
27	0.148	0.163	0.178	0.193	0.207
28	0.146	0.16	0.175	0.189	0.204
29	0.143	0.158	0.172	0.186	0.201
30	0.141	0.155	0.169	0.183	0.198
31	0.139	0.153	0.167	0.181	0.194
32	0.137	0.15	0.164	0.178	0.191
33	0.135	0.148	0.162	0.175	0.189
34	0.133	0.146	0.159	0.172	0.186
35	0.131	0.144	0.157	0.17	0.183
36	0.129	0.142	0.155	0.167	0.18
37	0.127	0.14	0.152	0.165	0.178
38	0.125	0.138	0.15	0.163	0.175
39	0.123	0.136	0.148	0.161	0.173
40	0.122	0.134	0.146	0.158	0.17
41	0.12	0.132	0.144	0.156	0.168
42	0.119	0.13	0.142	0.154	0.166
43	0.117	0.129	0.14	0.152	0.164
44	0.115	0.127	0.139	0.15	0.162
45	0.114	0.125	0.137	0.148	0.16
46	0.113	0.124	0.135	0.146	0.158
47	0.111	0.122	0.133	0.144	0.156
48	0.11	0.121	0.132	0.143	0.154
49	0.108	0.119	0.13	0.141	0.152
50	0.107	0.118	0.129	0.139	0.15
51	0.106	0.116	0.127	0.138	0.148
52	0.105	0.115	0.126	0.136	0.146
53	0.103	0.114	0.124	0.134	0.145
54	0.102	0.112	0.123	0.133	0.143
55	0.101	0.111	0.121	0.131	0.141
56	0.1	0.11	0.12	0.13	0.14
57	0.099	0.109	0.119	0.128	0.138
58	0.098	0.107	0.117	0.127	0.137
59	0.097	0.106	0.116	0.126	0.135
60	0.096	0.105	0.115	0.124	0.134

Table A16.5 Capacity Check for Dren Matadero - 1 in 10 Year Storm

Dren Matadero Catchment

Rational coefficient (C)	0.6	System Time = Time of Concentration + Travel Time in Pipe	Mannings Flow Equation
Time of concentration	5 min	= Time of Concentration +(Length of Drain/Velocity)/60	Roughness coefficient (n) 0.013
Average velocity	3 m/s	Unit catchment discharge is as shown in the table below.	

Drain Pipe/ Catchment	Length	Area	Cumulative area	Pipe Travel Time	System Time	Unit Catchment Discharge	Design Discharge	Existing Drain: Section Properties	Nearest Standard Size	Slope	Velocity	Capacity (0.9 H)	Remarks
	m	ha		min	min	$m^3/(s.ha)$	m^3/s	m x m	m x m	m/km	m/s	m3/s	
1	1060	30.1		5.9	10.9	0.242	7.274						
2	1550	68.72	98.82	8.6	19.5	0.202	19.929						
	To 7												
3	970	30.91	30.91	5.4	10.4	0.248	7.676						
	To 5												
4	1040	31.28		5.8	10.8	0.242							
5	540	60.80	122.99	3.0	13.8	0.227							
6	870	46.21	169.20	4.8	18.6	0.205	34.686	2.44×2.13(por E:8ft×7ft)	2.40×2.16	6.0	4.94	22.423	excessive velocity
7	1160	120.94	388.96	6.4	25.9	0.180	70.013	3.66×2.44(por D:12ft×8ft)	3.60×2.52	1.6	3.1	24.400	
	To 12												
8	1250	68.07		6.9	11.9	0.237							
9	880	53.27	121.34	4.9	16.8	0.213	25.886	2.13×1.83(por H:7ft×6ft)	2.10×1.89	4.0	3.69	12.823	
	To 11												
10	1830	54.68		10.2	15.2	0.222							
11-1	340	60.94	236.96	1.9	17.1			2.44×1.98(por G:8ft×6ft6in)	2.40×1.92	4.5	4.13	16.624	excessive velocity
11-2	610			3.4	20.5	0.193	45.812	3.35×2.44(por F:11ft×8ft)	3.40×2.38	1.2	2.58	18.144	
12-1	531							2 No. ×3.66×2.44(por C:2×12ft×8ft)	3.60×2.52	1.3	2.79	43.988	2 x 21.994
12-2	305	89.81	715.73	5.4	31.3	0.170	121.674	2 No. ×4.27×2.44(por B:2×214ft×8ft)	4.20×2.52	1.2	2.82	51.458	2 x 25.729
12-3	134							2 No. ×4.88×2.82(por A:2×16ft×9ft3in)	4.80×2.88	1.0	2.81	67.066	2 x 33.533
	to Ensenada Atares												

2×4.88×2.82(por A:2×16ft×9ft3in)
2×4.27×2.44(por B:2×214ft×8ft)
2×3.66×2.44(por C:2×12ft×8ft) : representative section of 12

3.66×2.44(por D:12ft×8ft)
2.44×2.13(por E:8ft×7ft)
3.35×2.44(por F:11ft×8ft)

2.44×1.98(por G:8ft×6ft6in)
2.13×1.83(por H:7ft×6ft)

Table A16.6 Capacity Check for Dren Agua Dulce - 1 in 10 Year Storm

Dren Agua Dulce Catchment

Rational coefficient (C)	0.5	System Time = Time of Concentration + Travel Time in Pipe	Mannings Flow Equation	
Time of concentration	5 min	= Time of Concentration +(Length of Drain/Velocity)/60	Roughness coefficient (n)	0.013
Average velocity	3 m/s	Unit catchment discharge is as shown in the table below.		

Drain Pipe/ Catchment	Length	Area	Cumulative area	Pipe Travel Time	System Time	Unit Catchment Discharge	Design Discharge	Existing Drain					
								Section Properties	Nearest Standard Size	Slope	Velocity	Capacity (0.9 H)	Remarks
	m	ha		min	min	$m^3/(s.ha)$	m^3/s	m x m	m x m	m/km	m/s	m^3/s	
1	1180	58.58		6.6	11.6	0.198	11.618						
2	110	31.14	89.72	0.6	12.2	0.198	17.794						
3	170	22.42	112.14	0.9	13.1	0.193	21.680						
4	470	73.98	186.12	2.6	15.7	0.182	33.812						
5	320	14.22	200.34	1.8	17.5	0.175	35.060	2.20×1.70	2.2×1.76	6.0	4.5	15.221	Excessive velocity
	To 7												
6		9.33											
7	460	4.57	214.24	2.6	20.1	0.168	36.064	2.75×2.08(9ft×6ft10in)	2.70×2.16	5.0	4.11	13.894	
8	670	70.5	284.74	3.7	23.8	0.157	44.609	2.75×2.08(9ft×6ft10in)	2.70×2.16	4.5	3.9	13.181	
9	370	44.35	329.09	2.1	25.9	0.150	49.364	3.66×2.13(por K: 12ftx7ft)	3.6×2.16	3.3	4.22	28.296	Excessive velocity
	To 15												
10	1130	36.69		6.3	11.3	0.202	7.399						
11	520	70.75	107.44	2.9	14.2	0.188	20.235						
12	490	7.94	115.38	2.7	16.9	0.178	20.576	2.74×1.90(9ft×6ft3in)	2.70×1.89	2.5			Horse-shoe shape
	To 14												
13		64.59							Via Blanca				
14	310	49.69	229.66	1.7	18.6	0.172	39.425	2.74×1.90(por9ft×6ft3in)	2.70×1.89	2.7	3.32	14.717	
15	370	6.79	565.54	2.1	28.0	0.145	82.003	4.88×2.50(por B: 16ft×8ft2in)		2.7	4.44	48.751	excessive velocity
	To 17												
16		81.66						2.13×1.82(por I: 7ft×6ft)	2.1×1.89	1.5	2.26	7.853	
17	470	26.3	673.5	2.6	30.6	0.138	93.168	4.88×3.40(por A: 16ft×11ft2in)	4.9×3.43	1.4	3.56	51.934	
	To Ensenada de Atares												

Table A16.7 Capacity Check for Dren Pastrana - 1 in 10 Year Storm

Dren Pastrana Catchment

Rational coefficient (C) 0.5   System Time = Time of Concentration + Travel Time in Pipe   Mannings Flow Equation

Time of concentration 5 min   = Time of Concentration +(Length of Drain/Velocity)/6 Roughness coefficient (n) 0.013

Average velocity 3 m/s   Unit catchment discharge is as shown in the table below.

Drain Pipe/ Catchment No.	Length	Area	Cumulative area	Pipe Travel Time	System Time	Unit Catchment Discharge	Design Discharge	Existing Drain					
								Section Properties	Nearest Standard Size	Slope	Velocity	Capacity (0.9 H)	Remarks
	m	ha		min	min	$m^3/(s.ha)$	m^3/s	m or m x m	m x m	m/km	m/s	m3/s	
1	420	25.36		2.3	7.3	0.222	5.621						
2	400	26.65	52.01	2.2	9.5	0.207	10.749	1.37					
3	360	19.94	71.95	2.0	11.5	0.198	14.270	1.83×1.42	1.80×1.44	4.0	3.22	7.278	
4	200	27.43	99.38	1.1	12.6	0.193	19.213	1.83×1.52	1.80×1.44	4.0	3.22	7.278	
								2.13×1.83	2.1×1.890	3.5	3.45	11.995	
5	800	69.03	168.41	4.4	17.0	0.178	30.033	2.40×2.15	2.40×2.16	3.0	3.49	15.855	
6	450	48.01	216.42	2.5	19.5	0.168	36.431	2.40×2.50	2.40×2.40	2.5	3.28	16.585	
7	460	45.98	262.4	2.6	22.1	0.162	42.421	2.48×2.46	2.50×2.50	2.0	3.01	17.54	
	to Luyano River												

Table A16.8 Capacity Check for Dren Lawton - 1 in 10 Year Storm

Dren Lawton Catchment

Rational coefficient (C) 0.5
Time of concentration 5 min
Average velocity 3 m/s

System Time = Time of Concentration + Travel Time in Pipe
= Time of Concentration +(Length of Drain/Velocity)/60
Unit catchment discharge is as shown in the table below.

Mannings Flow Equation
Roughness coefficient (n) 0.013

Drain Pipe/ Catchment	Length	Area	Cumulative area	Pipe Travel Time	System Time	Unit Catchment Discharge	Design Discharge	Existing Drain: Section Properties	Existing Drain: Nearest Standard Size	Existing Drain: Slope	Existing Drain: Velocity	Existing Drain: Capacity (0.9 H)	Existing Drain: Remarks
	m	ha		min	min	$m^3/(s.ha)$	m^3/s	m or m x m	m or m x m	m/km	m/s	m^3/s	
1	590	32.24		3.3	8.3	0.217	6.985						
2	360	34.47	66.71	2	10.3	0.207	13.787						
	To 4												
3	660	55.75	122.46	3.7	14.0	0.189	10.537						
4	670	57.00	179.46	3.7	17.7	0.188	33.798						
5	550	23.23	202.69	3.1	20.8	0.178	36.146						
6	470	67.16	269.85	2.6	23.4	0.168	45.425	2.54	2.5	3	3.08	15.118	
7	320	23.49	293.34	1.8	25.2	0.162	47.423	3.66 × 2.59	3.70 × 2.59	2.0	3.53	29.348	
	to Luyano River												

StormCalc190903Lawton

Table A16.9 Input Data for Dren Matadero

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (ha)	Section Size	Upstream Invert Elevation (m)	Length (m)	Downstream Invert Elevation (m)	Constructed Slope (m/km)	Mannings n	Full Capacity (m³/s)	Upstream Ground Elevation (m)	Downstream Ground Elevation
P-1	I-1	J-1	120.94	2440 x 2130 mm	4.89	145.5	3.94	6.5	0.016	18.0	7.44	7.36
P-2	J-1	J-2		M-2440 x 1980 mm	3.94	537.5	-0.04	7.4	0.016	17.4	7.36	3.97
P-3	J-2	J-3		3660 x 2440 mm	-0.04	219.0	-0.46	1.9	0.016	19.8	3.97	4.47
P-4	J-3	I-2		3660 x 2440 mm	-0.46	244.0	-0.70	1.0	0.016	14.2	4.47	2.09
P-5	I-2	J-4	89.81	4270 x 2440 mm	-0.70	300.0	-1.06	1.2	0.016	38.1	2.09	2.1
P-6	J-4	J-5		4270 x 2440 mm	-1.06	254.0	-1.40	1.3	0.016	40.2	2.1	1.46
P-7	J-5	J-6		4270 x 2440 mm	-1.40	289.5	-1.76	1.2	0.016	38.8	1.46	2.56
P-8	J-6	O-1		4880 x 2820 mm	-1.76	150.5	-1.84	0.5	0.016	36.8	2.56	0
P-9	I-3	J-7	30.91	750 mm	37.94	264.5	28.00	37.6	0.016	1.8	40.02	29.56
P-10	J-7	J-8		1200 mm	28.00	150.0	26.12	12.5	0.016	3.7	29.56	28.72
P-11	J-8	J-9		1200 mm	26.12	97.0	24.98	11.8	0.016	3.6	28.72	28.28
P-12	J-9	I-4		1650 mm	24.98	381.0	18.09	18.1	0.016	10.4	28.28	24.14
P-13	I-4	J-10	60.80	1900 mm	18.09	212.0	15.74	11.1	0.016	11.4	24.14	20.09
P-14	J-10	J-11		1900 mm	15.74	281.5	11.51	15.0	0.016	13.2	20.09	14.73
P-15	J-11	I-5		M-3000 x 2150 mm	11.51	169.0	10.65	5.1	0.016	21.0	14.73	14.5
P-16	I-5	J-12	46.21	M-3000 x 2150 mm	10.65	206.5	8.46	10.6	0.016	30.4	14.5	12.45
P-17	J-12	J-13		M-3000 x 2500 mm	8.46	151.5	7.94	3.4	0.016	21.3	12.45	11.05
P-18	J-13	J-14		M-3000 x 2500 mm	7.94	101.0	7.86	0.8	0.016	10.2	11.05	10.88
P-19	J-14	I-1		Platanito	7.86	328.0	4.89	9.1	0.02	84.3	10.88	7.44
P-23	I-6	J-15	31.28	600 mm	31.67	143.0	30.69	6.9	0.016	0.4	33.18	31.63
P-24	J-15	J-16		600 mm	30.69	81.0	29.55	14.1	0.016	0.6	31.63	31.06
P-25	J-16	J-17		600 mm	29.55	118.5	27.37	18.4	0.016	0.7	31.06	29.32
P-26	J-17	J-18		600 mm	27.37	71.0	26.73	9.0	0.016	0.5	29.32	28.53
P-27	J-18	J-19		900 mm	26.73	45.0	26.36	8.2	0.016	1.4	28.53	28.42
P-28	J-19	J-20		1050 mm	26.36	107.5	25.61	7.0	0.016	1.9	28.42	27.8
P-29	J-20	J-21		1050 mm	25.61	90.5	24.98	7.0	0.016	1.9	27.8	27.33
P-30	J-21	J-22		1050 mm	24.98	102.5	23.14	18.0	0.016	3.1	27.33	25.81

Table A16.9 Input Data for Dren Matadero

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (ha)	Section Size	Upstream Invert Elevation (m)	Length (m)	Downstream Invert Elevation (m)	Constructed Slope (m/km)	Mannings n	Full Capacity (m³/s)	Upstream Ground Elevation (m)	Downstream Ground Elevation
P-31	J-22	J-23		1200 mm	23.14	59.5	20.32	47.4	0.016	7.2	25.81	24.47
P-32	J-23	I-4		1350 mm	20.32	83.5	18.09	26.7	0.016	7.4	24.47	24.14
P-33	I-7	J-24	98.82*	M-2440 x 1980 mm	27.50	140.5	23.86	25.9	0.016	32.5	30.08	26.31
P-34	J-24	J-25		M- 2260 x 1530 mm	23.86	122.5	21.04	23.0	0.016	19.4	26.31	32.89
P-35	J-25	J-26		M- 2260 x 1530 mm	21.04	152.5	18.42	17.2	0.016	16.8	32.89	21.27
P-36	J-26	J-27		M- 2260 x 1530 mm	18.42	51.0	17.80	12.2	0.016	14.1	21.27	20.34
P-37	J-27	J-28		M-2340 x 1400 mm	17.80	89.5	16.42	15.4	0.016	14.7	20.34	18.48
P-38	J-28	J-29		M-2340 x 1400 mm	16.42	75.0	15.79	8.4	0.016	10.8	18.48	18.18
P-39	J-29	J-30		M-2340 x 1400 mm	15.79	169.0	14.35	8.5	0.016	10.9	18.18	16.82
P-40	J-30	J-31		M-2340 x 1400 mm	14.35	68.5	14.26	1.3	0.016	4.3	16.82	16.36
P-41	J-31	J-32		M-2340 x 1400 mm	14.26	71.5	13.77	6.9	0.016	9.8	16.36	16.37
P-42	J-32	J-33		M-2340 x 1400 mm	13.77	160.5	9.89	24.2	0.016	18.4	16.37	11.8
P-43	J-33	J-34		M- 2000 x 2000 mm	9.89	178.5	8.45	8.1	0.016	14.1	11.8	12.5
P-44	J-34	I-1		M-2130 x 1600 mm	8.45	259.0	4.89	13.7	0.016	14.8	12.5	7.44
P-45	I-8	J-35	68.07	750 mm	-	113.5	-	-	0.016	-	27.6	26.7
P-46	J-35	J-36		750 mm	-	113.5	-	-	0.016	-	26.7	26.3
P-47	J-36	J-37		750 mm	-	38.5	-	-	0.016	-	26.3	25
P-48	J-37	J-38		1050 mm	21.72	61.0	15.15	107.7	0.016	7.6	25	23.5
P-49	J-38	J-39		1050 mm	-	65.0	-	-	0.016	-	23.5	23.2
P-50	J-39	J-40		1800 mm	-	218.0	-	-	0.016	-	23.2	24
P-51	J-40	J-41		1900 mm	-	194.5	-	-	0.016	-	24	20
P-52	J-41	I-9		1900 mm	-	82.0	-	-	0.016	-	20	16
P-53	I-9	J-42	53.27	1900 mm	-	185.0	-	-	0.016	-	16	11.37
P-54	J-42	J-43		M 1870 x 1520 mm	-	117.0	-	-	0.016	-	11.37	9.94
P-55	J-43	J-44		M 1870 x 1520 mm	-	178.0	-	-	0.016	-	9.94	8.52
P-56	J-44	J-45		M 1870 x 1520 mm	-	322.5	-	-	0.016	-	8.52	6.11
P-57	J-45	I-10		2130 x 1830 mm	-	59.0	-	-	0.016	-	6.11	5.34

MataderoStormCADDataSheet1

Table A16.9 Input Data for Dren Matadero

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (ha)	Section Size	Upstream Invert Elevation (m)	Length (m)	Downstream Invert Elevation (m)	Constructed Slope (m/km)	Mannings n	Full Capacity (m³/s)	Upstream Ground Elevation (m)	Downstream Ground Elevation
P-58	I-10	J-46	60.94	2130 x 1830 mm	-	75.5	-	-	0.016	-	5.34	4.94
P-59	J-46	J-47		M-2440 x 1980 mm	-	89.0	-	-	0.016	-	4.94	4.48
P-60	J-47	J-48		M-2440 x 1980 mm	-	95.5	-	-	0.016	-	4.48	3.71
P-61	J-48	J-49		M-2440 x 1980 mm	-	78.0	-	-	0.016	-	3.71	3.06
P-62	J-49	J-50		M- 3350 x2440 mm	-	70.5	-	-	0.016	-	3.06	3.43
P-63	J-50	J-51		M- 3350 x2440 mm	-	98.5	-	-	0.016	-	3.43	3.53
P-64	J-51	J-52		M- 3350 x2440 mm	-	101.5	-	-	0.016	-	3.53	3.57
P-65	J-52	J-53		M- 3350 x2440 mm	-	217.0	-	-	0.016	-	3.57	2.46
P-66	J-53	I-2		M- 3350 x2440 mm	-	126.0	-	-	0.016	-	2.46	2.09
P-67	I-12	J-55	54.68	450 mm	-	203.0	-	-	0.016	-	39.2	38
P-68	J-55	J-56		600 mm	-	132.0	-	-	0.016	-	38	25.5
P-69	J-56	J-57		900 mm	-	450.5	-	-	0.016	-	25.5	19
P-70	J-57	J-58		M-1100 mm	-	286.0	-	-	0.016	-	19	15.83
P-71	J-58	J-59		M-1100 mm	-	91.0	-	-	0.016	-	15.83	15.38
P-72	J-59	J-60		M-1100 mm	-	79.0	-	-	0.016	-	15.38	15.26
P-73	J-60	J-61		M-1100 mm	-	35.0	-	-	0.016	-	15.26	14.98
P-74	J-61	J-62		1200 mm	-	86.0	-	-	0.016	-	14.98	13.31
P-75	J-62	J-63		1200 mm	-	61.5	-	-	0.016	-	13.31	12.82
P-76	J-63	J-64		1200 mm	-	55.5	-	-	0.016	-	12.82	12.45
P-77	J-64	J-65		1200 mm	-	51.0	-	-	0.016	-	12.45	11.6
P-78	J-65	J-66		1200 mm	-	73.5	-	-	0.016	-	11.6	9.61
P-79	J-66	J-67		1200 mm	-	75.0	-	-	0.016	-	9.61	6.95
P-80	J-67	J-68		1650 mm	-	82.0	-	-	0.016	-	6.95	6.03
P-81	J-68	J-69		1650 mm	-	66.0	-	-	0.016	-	6.03	5.09
P-82	J-69	I-10		1650 mm	-	56.5	-	-	0.016	-	5.09	5.34

Note : * - Includes the sub-tributary area 1 and 2.