E.4.4 DRAINAGE CHANNELS

(1) Drainage Network

Numerous drainage channels exist in the study area, and those connections are very complicated. In the present study, totally 74 km in length for esteros/creeks and 35 km in length for drainage mains have been identified based upon the results of previous studies, especially SEDLMM (2000), and the drainage inventory and maps provided by MMDA. The fieldworks have been also conducted to confirm those connections by the Study Team with the help of MMDA. The results have been summarized as schematic diagram of existing drainage network for the North Manila and South Manila as shown in *Figures E.4.11* and *E.4.12*, respectively. The figures also show the definition of the start and end points of each estero/creek and drainage main. Drainage channels have been further divided to channel sections as shown in *Figure E.4.13*.

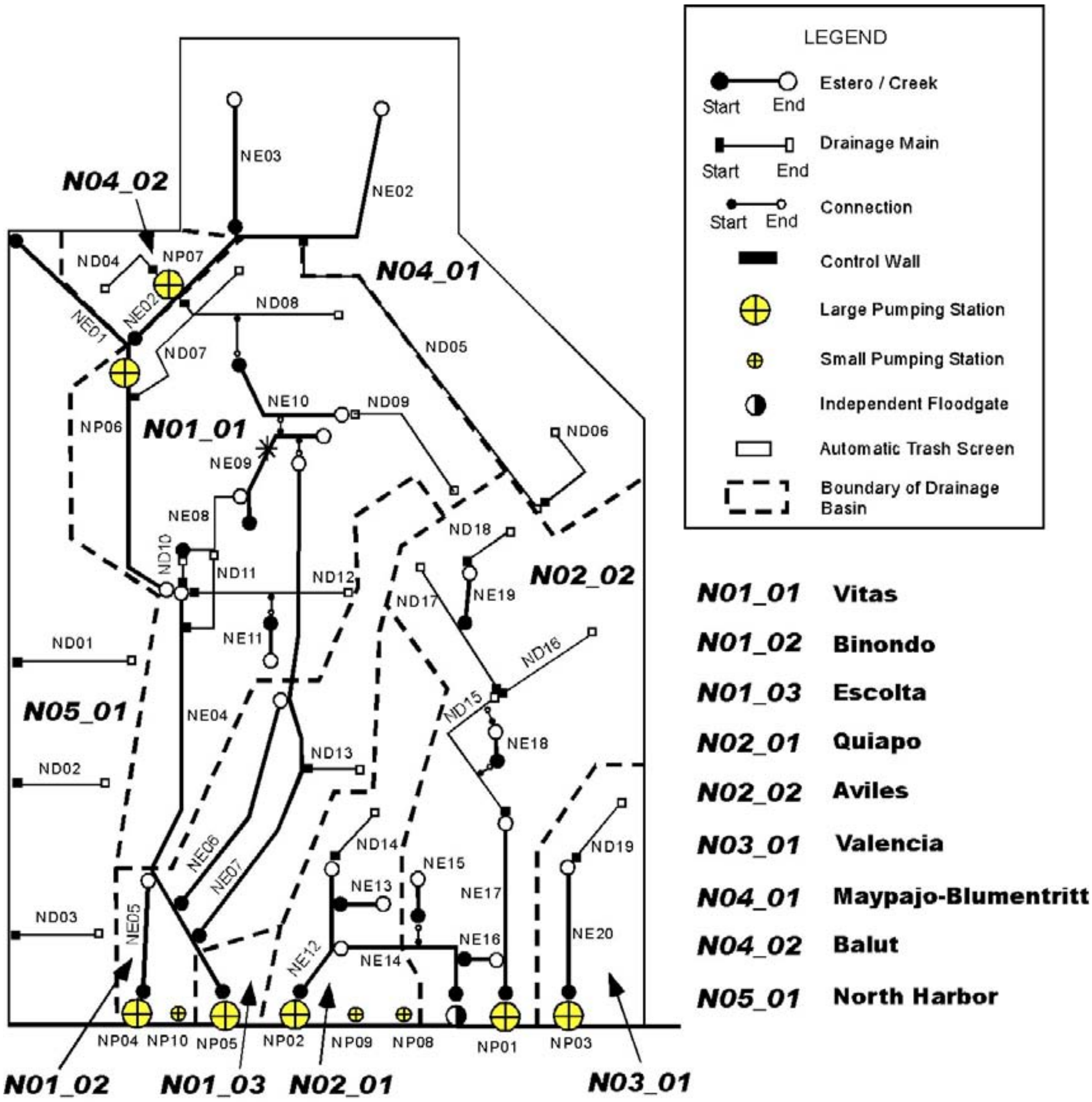
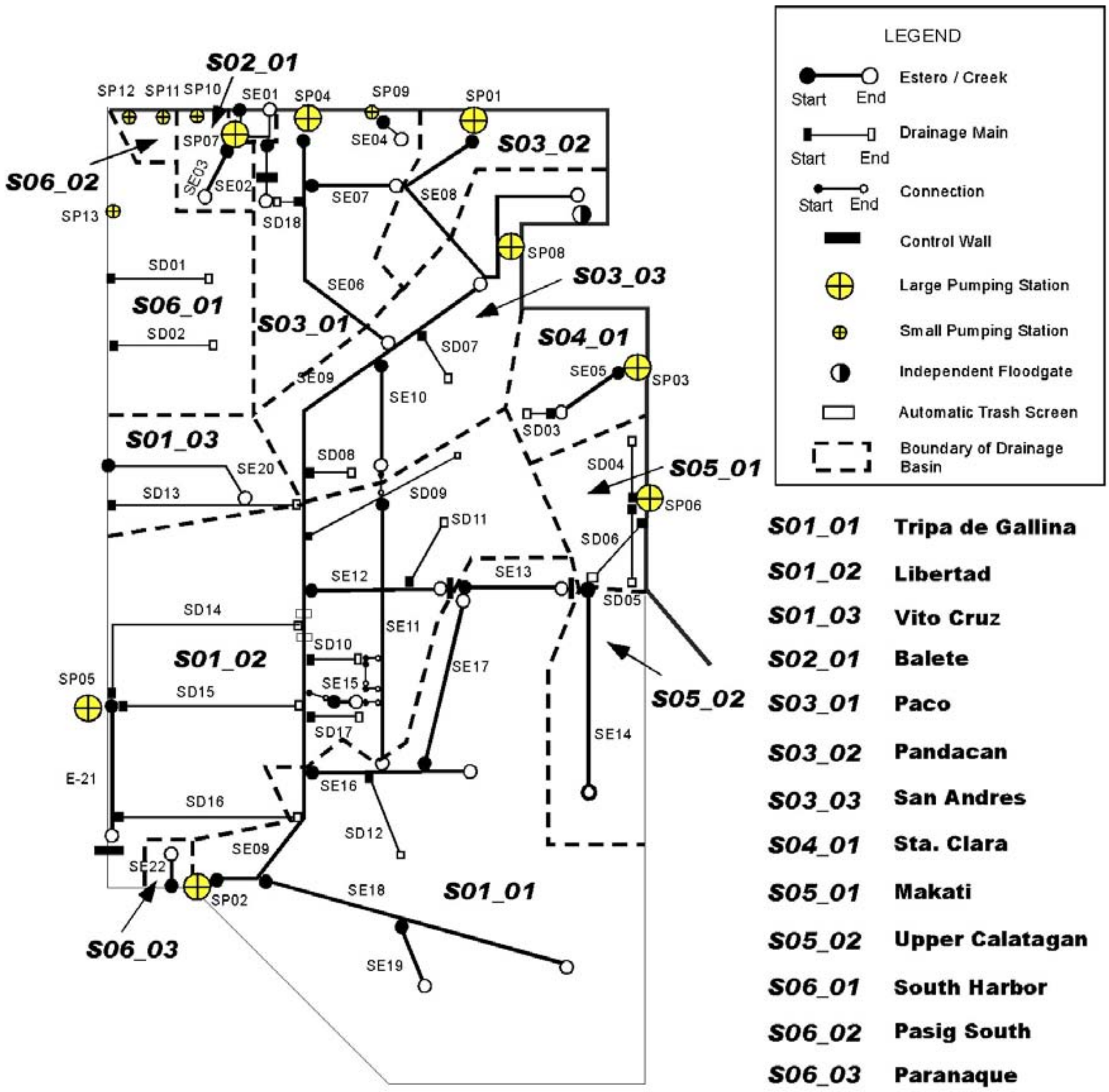


Figure E.4.11 Schematic Diagram of Drainage Network in North Manila



Note: The boundary between S01_01 and S01_02 is quite unclear. The stormwater collected through SE13, SE17, SE16, SD12 may be drained by SP05(Libertad Pumping Station).

Figure E.4.12 Schematic Diagram of Drainage Network in South Manila

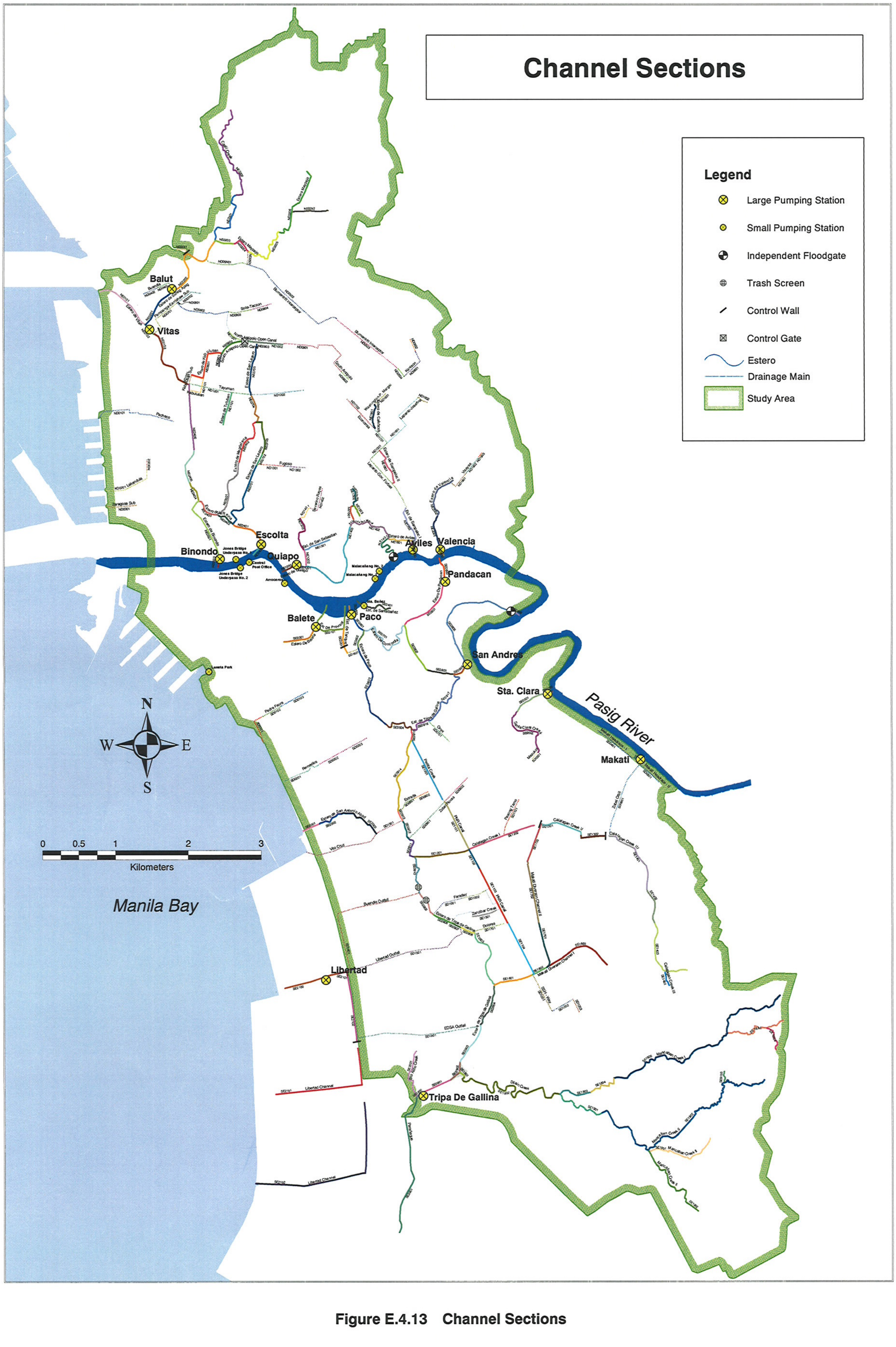


Figure E.4.13 Channel Sections

(2) Dimensions of Drainage Channels

1) Estero / Creek

There are 20 esteros/creeks in North Manila and 22 esteros/creeks in South Manila. Among those, longitudinal and cross-sectional profiles of 30 esteros/creeks were surveyed in 2000 in the course of SEDLMM. In the present study, survey on most of the remained esteros/creeks has been conducted supplementary. The current conditions of estero/creeks are summarized using data obtained by both SEDLMM and the Study.

Table E.4.22 summarizes main dimensions of esteros/creeks. The longest is Estero de Tripa de Gallina that is 7600 m in length, and the shortest is Zanzibar Creek in South Manila. The width varies from a few meters to 75 m. Along the esteros/creeks are various bank protection works by means of steel sheet piles, concrete sheet piles and wet masonry, and drainage culverts.

Figure E.4.14 shows longitudinal variations of bed and bank elevations and river width in Estero de Tripa de Gallina, Calatagan Creek I and Estero de Sunog Apog/Maypajo, as examples.

In *Figure E.4.14*, longitudinal variation of bed elevations in Estero de Tripa de Gallina in 1990 and 1995 and the previously planned bed elevation are also shown. The bed elevation in 2004 is higher than those in 1990 and 1995 in general. Aggradation of riverbed is severe, which makes the existing riverbed 1 - 3 m higher than the planned one. It causes reduction of discharge capacity.

Existing Calatagan Creek I is basically shallow and narrow, which leads small discharge capacity. In addition, there is a neck point at the section where the railroad along South Super Highway crosses.

Bed elevation in Estero de Sunog Apog/Maypajo seems to become high compared to before. It is estimated that the previous bed elevation at the outlet of Blumentritt interceptor is about EL. 8 m. However, the bed elevation in 2000 is almost EL. 10.5 m, which makes the outlet of Blumentritt interceptor mostly closed.

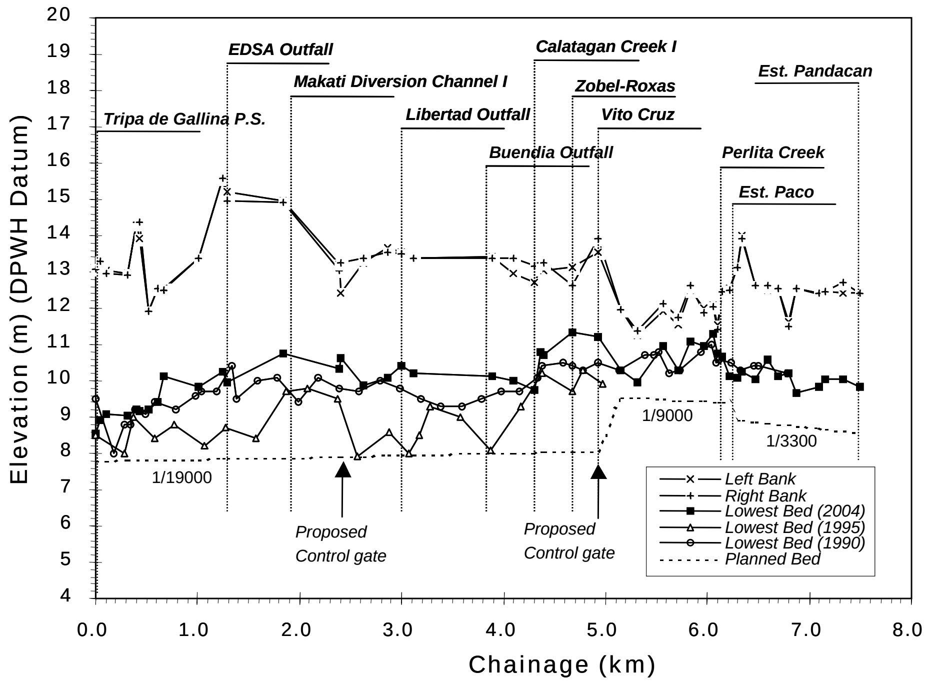
The longitudinal profiles of the other esteros/creeks are shown in *Annex E.1*

Table E.4.22 Main Dimensions of Esteros/Creeks

Block_ID	Code	Name	Length (m)	Width (m)	Source
N01	NE01	Estero de Vitas (*1)	1990	15 - 72	a
	NE04	Estero dela Reina	3020	8-21	a
	NE05	Estero de Binondo	1040	15 -32	a
	NE06	Estero de Magdalena	1510	5 - 36	b
	NE07	Estero de San Lazaro	2830	3 - 16	b
	NE08	Estero de Kabulusan	690	9	b
	NE09	South Antipolo Open Canal	830	2.5 - 7	b
	NE10	North Antipolo Open Canal	780	3 - 4.5	b
	NE11	Estero de Tutuban	450	2 - 2.5	a
N02	NE12	Estero de Quiapo	1120	12 - 26	b
	NE13	Estero de San Sebastian	380	6 - 12	b
	NE14	Estero de San Miguel / Uli-Uli	2670	7.5 - 21	b
	NE15	Estero de Alix	650	2.5 - 3	a
	NE16	Estero de Aviles	380	4.5 - 11	b
	NE17	Estero de Sampaloc I	720	8 -16	b
	NE18	Estero de Sampaloc II	510	2 -10	a
	NE19	Estero de Calubcob	340	9 - 10	b
N03	NE20	Estero de Valencia	1220	5 - 27	a
N04	NE02	Estero de Sunog Apog / Maypajo	4270	5 -72	b
	NE03	Casili Creek	2380	2.5 - 7.5	b
S01	SE09	Estero de Tripa de Gallina (*2)	7640	4 - 30	a
	SE11	PNR canal	2660	1.5 - 3	b
	SE12	Calatagan Creek I	1710	4.5 - 8	b
	SE13	Calatagan Creek II	1000	6 - 8.5	b
	SE15	Zanzibar Creek	330	5 - 7.5	b
	SE16	Makati Diversion Channel I	1790	4 - 10	b
	SE17	Makati Diversion Channel II	1990	6.5 - 10	b
	SE18	Dilain Creek / Maricaban Creek I	6320	5 -15	b
	SE19	Maricaban Creek II	4240	6 - 25	b
	SE20	Estero de San Antonio Abad	1220	3 - 6	a
	SE21	Libertad Channel	900	15 - 20	a
S02	SE03	Estero de Balete	550	6 - 12	a
S03	SE01	Estero de Provisor	1020	15 - 26	a
	SE02	Estero de Tanque	340	5 - 25	a
	SE04	Estero de Santebanez	520	4 - 10	a
	SE06	Estero de Paco	2400	6 - 23	b
	SE07	Estero de Concordia	1070	3 - 18	a
	SE08	Estero de Pandacan	4320	3 - 16	a
	SE10	Perlita Creek	920	3 - 4	b
S04	SE05	Santa Clara Creek	1490	3 - 8	a
S05	SE14	Calatagan Creek III	2560	5.5 - 7	b
S06	SE22	Sto Nino Creek	730	N/A	N/A

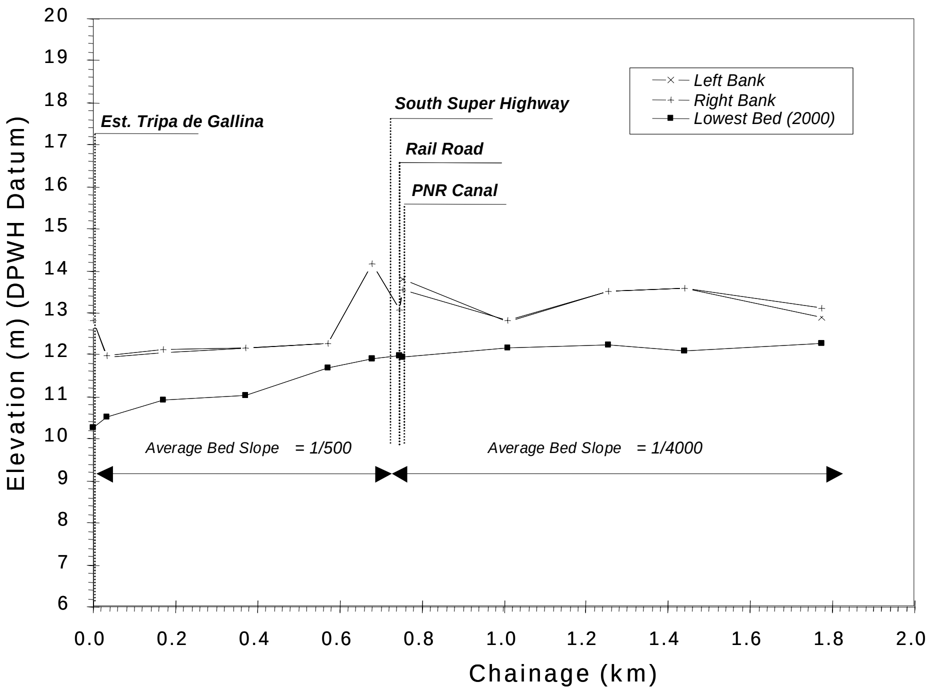
Source *a: JICA Study Team, b: SEDLMM database (2000)*

Note **1: This is included also in N04. *2: This is included also in S02.*



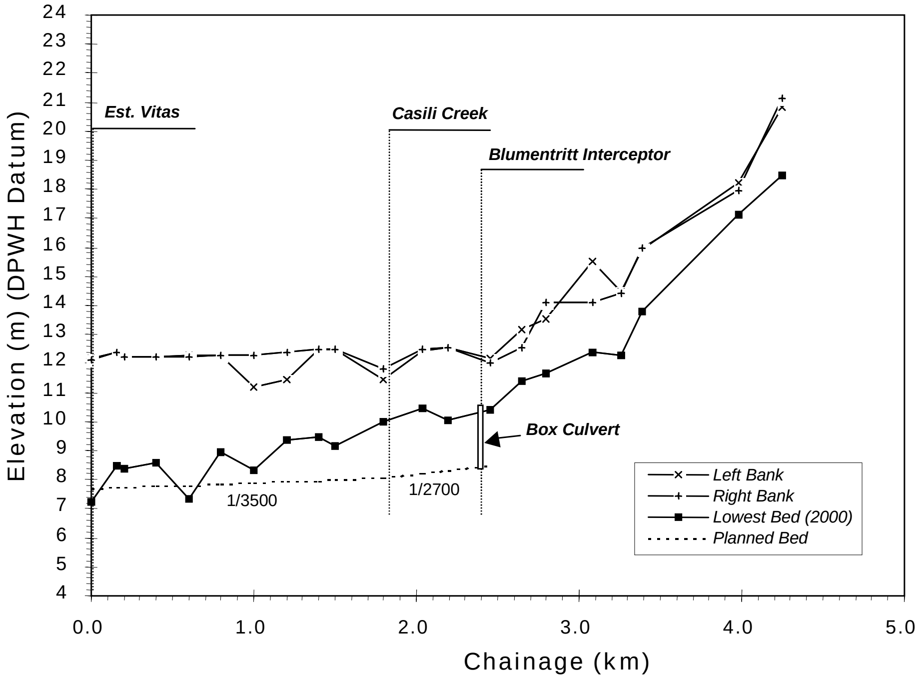
Source: 1) JICA Study Team
2) DPWH, JICA, The Study on Flood Control and Drainage Project in Metro Manila, 1990.
3) DPWH, Metro Manila Flood Control (II) Project (PH-79), Drawings for Estero Improvement, 1991.
4) Public Estates Authority, The Study on the Updated Drainage Plan for Section II of Manila Bay Reclamation Area, Pasay City and Paranaque, Metro Manila, 1995.

Figure E.4.14 Longitudinal Profile of Estero/Creek (Tripa de Gallina) (1/3)



Source: JICA, DPWH, MMDA, Study on the Existing Drainage Laterals in Metro Manila in the Core Area of the Philippines, 2000.

Figure E.4.14 Longitudinal Profile of Estero/Creek (Calatagan Creek I) (2/3)



Source: 1) JICA, DPWH, MMDA, Study on the Existing Drainage Laterals in Metro Manila in the Core Area of the Philippines, 2000.

2) DPWH, Metro Manila Flood Control (II) Project (PH-79), Drawings for Estero Improvement, 1991

Figure E.4.14 Longitudinal Profile of Estero/Creek (Sunog Apog/Maypajo) (3/3)

2) Drainage Main

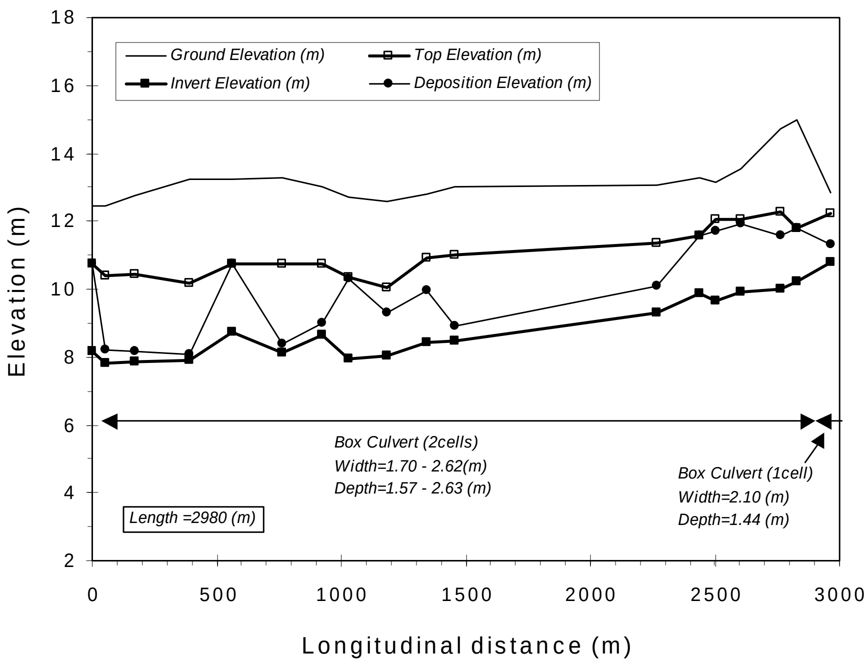
There exist 18 and 19 drainage mains in North Manila and in South Manila, respectively. Based upon the database for drainage laterals developed by SEDLMM, the dimensions of the drainage mains can be summarized as shown in *Table E.4.23*.

The length of the drainage mains ranges 130 m to 2980 m. The longest is Blumentritt interceptor in North Manila, whereas the shortest is Kabulusan Sub main in North Manila. Most of the drainage mains consist of one or two box culverts.

In SEDLMM, the deposition depth in the drainage main was also investigated, which clarifies how much the drainage cross-section had been clogged by silt or solid waste at the moment the survey was conducted in 2000. The longitudinal profile of Blumentritt interceptor is shown in *Figure E.4.15* as an example. Deposition fully occupied at the outlet and the middle and upper parts in Blumentritt interceptor. There were the regions where no deposition was observed. However, only one neck point can significantly reduce discharge capacity even if other places have enough cross-sectional area. Thus, the discharge capacity of Blumentritt interceptor was almost zero at the moment the survey was conducted in 2000.

The longitudinal profiles of the other drainage mains are shown in *Annex E.1*

Many of maintenance holes of drainage mains have been improperly operated and maintained. Some of them have been covered by road pavement or structures and no longer utilized. This would be one of the reasons why the deposits have been accumulating so much in drainage mains.



Note: Condition of deposition in 2000 is shown.
Data Source: SEDLMM database (2000)

Figure E.4.15 Longitudinal Profile of Drainage Main (Blumentritt Interceptor)

Table E.4.23 Dimensions of Drainage Mains (1/2)

Block_ID	Code	Name	Length (m)	Location of manhole (m)	Type	Number of Cell	Width (m)	Depth (m) or Diameter (m)	DownStream Condition	Downstream WL Condition	DownStream Water Level (m)	Qcap (m^3/s) with Deposition (2000)	Qcap (m^3/s) Original	A (km^2)	Q10 (m^3/s)	Q5 (m^3/s)	Q3 (m^3/s)	Q2 (m^3/s)	Judgement Existing	Judgement Original	Declogging Volume (m3)
N01	ND07	Pampanga-Earnshaw Sub	1040	44 - 501	Box Culvert	2	2.60 - 2.80	2.40 - 3.36	Estero	Top Elev. of D.M.	10.44	26	31	1.85	35.4	30.9	26.7	23.2	4	2	606
				652 - 1037	Box Culvert	1	2.20 - 3.20	2.20 - 2.40		Top Elev. of D.M.	10.44	4	12	0.49	11.4	10.0	8.6	7.5	5	1	1017
	ND08	Solis-Tecson	1430	0 - 60	Box Culvert	1	2.00	1.30 - 1.52	Drainage Main					-	-	-	-	-	-	-	47
				166 - 1004	Box Culvert	2	1.50 - 2.00	1.09 - 1.53		Top Elev. of D.M.	10.21	2.6	8	1.14	23.0	20.1	17.4	15.2	5	5	1498
				1041 - 1359	Box Culvert	1	2.00	1.15 - 1.48		Top Elev. of D.M.	10.21	1.5	6	1.14	23.0	20.1	17.4	15.2	5	5	370
				1428	Pipe	1		1.02		Top Elev. of D.M.	10.21	1.4	4	0.71	16.1	14.1	12.2	10.6	5	5	388
	ND09	South Antipolo	1370	0 - 1218	Box Culvert	1	3.00 - 4.50	1.85 - 2.67	Estero	Top Elev. of D.M.	12.05	0	9	0.59	11.0	9.6	8.3	7.2	5	3	7261
				1375	Box Culvert	1	2.00	2.14	Estero	Top Elev. of D.M.	12.05	0	0	0.22	4.1	3.6	3.1	2.7	5	5	358
	ND10	Kabulusan Sub	140	14 - 142	Box Culvert	1	2.81	2.40	Estero	Top Elev. of D.M.	10.15	10	44	0.64	9.8	8.6	7.4	6.4	1	1	415 (*A)
	ND11	Kabulusan	370	8 - 367	Box Culvert	1	3.35 - 5.80	2.00 - 2.70	Estero	Top Elev. of D.M.	11.30	0	35	0.64	9.5	8.3	7.1	6.1	5	1	1935
	ND12	Tayuman	1600	0 -692	Box Culvert	1	2.12 - 3.10	1.36 - 2.40	Estero	Top Elev. of D.M.	10.15	0	8	1.41	30.6	26.8	23.2	20.2	5	5	2921
				875-1303	Box Culvert	1	1.85-1.91	1.48 - 1.89	Estero	Top Elev. of D.M.	10.15	0	6	0.65	14.9	13.1	11.3	9.8	5	5	834
	ND13	Fugoso	670	0 - 365	Box Culvert	2	2.00 - 2.20	1.63 - 2.87	Estero	Top Elev. of D.M.	10.99	10	21	0.86	15.8	13.8	11.9	10.4	4	1	915
				470 - 546	Box Culvert	1	2.80 - 3.00	1.50		Top Elev. of D.M.	10.99	5	12	0.40	7.3	6.4	5.5	4.8	4	1	350
N02	ND14	Severino Reyes	650	70 - 220	Box Culvert	1	3.10 - 3.20	1.60	Estero	Top Elev. of D.M.	10.31	16	21	0.93	17.6	15.4	13.3	11.6	2	1	77
				332 - 648	Box Culvert	1	2.65 - 3.20	1.60 - 1.77	Estero	Top Elev. of D.M.	10.31	7	11	0.87	16.6	14.5	12.5	10.9	5	4	243
	ND15	Lepanto-Gov. Forbes	1160	0 - 1160	Box Culvert	3	3.40 - 4.00	1.75 - 3.15	Estero	Top Elev. of D.M.	11.52	13	25	2.55	36.4	31.6	27.3	23.6	5	4	7817
	ND16	Lepanto-Josefina	1060	0	Box Culvert	3	3.40	2.24	Drainage Main					-	-	-	-	-	-	-	-
				133 - 223	Box Culvert	2	2.00 - 2.12	2.00 - 2.24		Top Elev. of D.M.	11.06	21	33	1.31	21.9	19.1	16.5	14.3	2	1	1290
				916 - 1021	Box Culvert	1	4.10 - 4.30	3.00 - 3.24		Top Elev. of D.M.	11.06	13	20	0.94	17.9	15.7	13.5	11.8	4	1	144
	ND17	Economia	820	0 - 232	Box Culvert	3	2.30 - 3.40	2.25 - 2.70	Drainage Main	Top Elev. of D.M.	11.06	49	80	0.66	20.9	18.4	15.8	13.8	1	1	1562
				555 - 695	Box Culvert	1	1.40 - 1.53	2.20 - 2.70		Top Elev. of D.M.	11.06	4	9	0.20	5.7	5.0	4.3	3.7	4	1	469
	ND18	Washington-P. Margal	210	12 - 167	Box Culvert	1	2.80	2.37 - 2.48	Estero	Top Elev. of D.M.	11.18	5	26	0.24	6.0	5.3	4.5	3.9	3	1	485
N03	ND19	Visayas	670	2 - 324	Box Culvert	2	2.00	2.00	Estero	Top Elev. of D.M.	11.46	11	21	1.21	25.4	22.2	19.2	16.8	5	3	610
				403 - 573	Box Culvert	2	1.70	1.70		Top Elev. of D.M.	11.46	8	15	0.87	18.3	16.0	13.8	12.1	5	3	493
				673	Box Culvert	1	2.90	1.60		Top Elev. of D.M.	11.46	8	13	0.47	9.9	8.6	7.5	6.5	3	1	0
N04	ND05	Blumentritt Interceptor	2980	10 - 1463	Box Culvert	2	1.20 - 2.62	2.00 - 2.63	Estero	Top Elev. of D.M.	10.76	0	8	2.62	34.4	29.9	25.9	22.4	5	5	861
				2276 - 2840	Box Culvert	2	1.40 - 2.15	1.57 - 2.25		Top Elev. of D.M.	10.76	0	8	1.56	29.5	25.7	22.2	19.4	5	5	5895
				2978	Box Culvert	1	2.10	1.44		Top Elev. of D.M.	10.76	0	6	0.58	12.5	10.9	9.5	8.3	5	5	3817
	ND06	Kanlaon	640	0	Box Culvert	1	2.19	1.44	Drainage Main					-	-	-	-	-	-	-	0
				328 - 459	Pipe	1		0.61		Top Elev. of D.M.	12.22	0.2	0.4	0.58	12.5	10.9	9.5	8.3	5	5	188 (*A)
				483	Box Culvert	1	0.762	0.762		Top Elev. of D.M.	12.22	0.2	0.4	0.30	6.5	5.7	4.9	4.3	5	5	5 (*A)
	ND04	Buendia	510	125 - 293	Box Culvert	1	2.50 - 3.00	1.93 - 2.40	Balut PS	PSTL	10.70	6	16	0.49	17.3	15.2	13.1	11.4	5	2	459
				437 - 511	Box Culvert	1	2.50 - 3.00	1.66 - 1.67	Balut PS	PSTL	10.70	4	10	0.23	8.0	7.1	6.1	5.3	5	1	135
N05	ND01	Pacheco	1160	0 - 866	Box Culvert	1	4.00 - 4.40	1.60 - 2.72	Manila Bay	MHST	11.34	9	13	1.13	28.0	24.5	21.2	18.5	5	5	1879
				913 - 1041	Box Culvert	1	3.00	0.74 - 1.75	Manila Bay	MHST	11.34	3	4	0.34	8.5	7.4	6.4	5.6	5	5	0
	ND02	Lakandula	870	0 -212	Box Culvert	1	3.84 - 4.20	2.01 - 2.62	Manila Bay	MHST	11.34	1	43	0.62	20.9	18.4	15.8	13.8	5	1	3507
				740 - 873	Pipe	1		1.07	Manila Bay	MHST	11.34	0.4	1	0.13	4.4	3.9	3.3	2.9	5	5	13
	ND03	Zaragosa Sub	430	0 - 429	Pipe	1		0.91	Manila Bay	MHST	11.34	0	1	0.23	8.8	7.7	6.6	5.8	5	5	279

Note

1) Dimensions are basically based uopn SEDLMM database (2000).
2) PSTL: Pump Start Level, MHST: Mean High Spring Tide
3) *A: Declogging is not proposed in the master plan.

Judgment

1,2,3,4,5 = The discharge capacity and probable discharge
1 = The capacity is more than Q10.
2 = The capacity is Q10 - Q5.
3 = The capacity is Q5 - Q3.
4 = The capacity is Q3 - Q2.
5 = The capacity is less than Q2.

Table E.4.23 Dimensions of Drainage Mains (2/2)

Basin_ID	Code	Name	Length (m)	Location of manhole (m)	Type	Number of Cell	Width (m)	Depth (m) or Diameter (m)	DownStream Condition	Downstream WL Condition	DownStream Water Level (m)	Qcap (m^3/s) with Deposition (2000)	Qcap (m^3/s) Original	A (km2)	Q10 (m3/s)	Q5 (m3/s)	Q3 (m3/s)	Q2 (m3/s)	Judgement Existing	Judgement Original	Declogging Volume (m3)
S01	SD12	SSH-Way	1110	5 - 568	Box Culvert	1	3.00 - 5.30	2.50 - 3.70	Estero	Top Elev. of D.M.	13.97	27	33	0.72	15.6	13.7	11.8	10.3	1	1	150
				741	Box Culvert	1	2.00	0.95		Top Elev. of D.M.	13.97	12	18	0.58	12.7	11.1	9.6	8.3	2	1	161
				900 - 1108	Pipe	1		1.07 - 1.52		Top Elev. of D.M.	13.97	4	5	0.43	9.4	8.2	7.1	6.2	5	5	0
	SD09	Zobel Roxas	1160	0 - 725	Box Culvert	1	2.80 - 4.40	1.22 - 2.52	Estero	Top Elev. of D.M.	12.36	6	13.5	1.01	17.5	15.2	13.2	11.4	5	3	2026
				764 - 1157	Pipe	1		1.22		Top Elev. of D.M.	12.36	0.7	1.5	0.79	15.0	13.1	11.3	9.9	5	5	94
	SD10	Faraday	820	30 - 453	Box Culvert	2	1.50 - 1.96	0.91 - 1.29	Estero	Top Elev. of D.M.	11.54	4	5	0.82	17.0	14.8	12.8	11.1	5	5	51
				567 - 821	Pipe	2		0.85 - 1.07		Top Elev. of D.M.	11.54	1.5	2	0.63	13.0	11.4	9.8	8.6	5	5	47
	SD11	Pasong Tamo	540	0 - 303	Box Culvert	1	3.50 - 4.05	1.55 - 1.90	Estero	Top Elev. of D.M.	12.87	2.5	12	0.49	9.1	7.9	6.8	6.0	5	1	911
	SD14	Buendia Outfall	1990	15 - 1977	Box Culvert	2	3.50 - 3.80	2.50 - 3.25	Libertad PS	PSTL	9.900	33	56	4.74	57.5	49.8	43.0	36.8	5	2	7152
	SD15	Libertad Outfall	1800	14 - 1697	Box Culvert	1	3.00 - 4.80	2.35 - 3.13	Libertad PS	PSTL	9.900	11	22	1.36	27.6	24.1	20.8	18.1	5	3	2816
	SD16	EDSA Outfall	1720	25 - 911	Box Culvert	2	4.20 - 4.95	2.43 - 3.09	Libertad PS	PSTL	9.900	25	64	6.87	79.8	69.1	59.7	50.9	5	3	10142
	SD17	Dolores	430	0 - 430	Box Culvert	1	1.80 (*1)	2.50 (*1)	Estero	Top Elev. of D.M.	-	-	-	0.09	-	-	-	-	-	-	-
	SD13	Vito Cruz	1450	200 - 941	Box Culvert	1	1.52 - 2.00	1.30 - 1.63	Manila Bay	MHST	11.34	0	4	0.88	14.8	12.9	11.2	9.7	5	5	521
S03	SD18	United Nations Interceptor	170	0 - 150	Box Culvert	1	-	-	Estero	Top Elev. of D.M.	-	-	-	-	-	-	-	-	-	-	-
	SD07	Onyx	410	6 - 413	Box Culvert	1	2.50 - 2.60	1.30 - 2.15	Estero	Top Elev. of D.M.	12.79	0	0	0.23	5.2	4.5	3.9	3.4	5	5	456
	SD08	Estrada	520	4 - 306	Box Culvert	1	2.50 - 2.83	1.20 - 1.67	Estero	Top Elev. of D.M.	11.60	5	7	0.32	7.1	6.2	5.3	4.7	4	2	538
				388	Pipe	1		1.25		Top Elev. of D.M.	11.60	0.6	4	0.03	0.7	0.6	0.5	0.4	4	1	144
S04	SD03	Masukol	130	0 - 130	Box Culvert	1	3.00 (*1)	2.00 (*1)	Estero	Top Elev. of D.M.	-	-	-	0.09	-	-	-	-	-	-	-
S05	SD04	Makati Headrace-I	630	0 - 626	Box Culvert	1	4.06 - 5.20	2.30 - 2.50	Makati PS	PSTL	11.30	10	26	1.00	18.3	15.9	13.8	12.0	5	1	2280
	SD05	Makati Headrace-II	390	0 - 265	Box Culvert	1	2.97 - 3.54	1.95 - 2.63	Makati PS	PSTL	11.30	22	40	0.65	14.6	12.8	11.0	9.6	1	1	374
	SD06	Zobel Orbit	1220	0 - 541	Box Culvert	1	4.90 - 5.18	2.97 - 3.10	Pasig River	Top Elev. of D.M.	12.24	45	59	2.66	38.1	33.2	28.7	24.9	1	1	505
S06	SD01	Padre Faura	1160	0 - 374	Box Culvert	1	3.30 - 3.47	2.30 - 2.70	Manila Bay	MHST	11.34	19	26	0.93	24.9	21.8	18.8	16.4	3	1	375
				577 - 650	Box Culvert	1	2.20 - 2.70	2.03 - 2.37	Manila Bay	MHST	11.34	14	17	0.78	20.8	18.2	15.7	13.8	4	3	250
				982 - 1070	Box Culvert	1	2.20	1.33 - 1.88	Manila Bay	MHST	11.34	5	8	0.45	12.0	10.5	9.1	7.9	5	4	276
	SD02	Remedios	1350	0 - 418	Box Culvert	1	4.40	2.26 - 3.20	Manila Bay	MHST	11.34	26	52	0.92	23.2	20.4	17.6	15.4	1	1	1990
				1082	Box Culvert	1	2.60	1.28	Manila Bay	MHST	11.34	2.5	6	0.54	13.6	11.9	10.3	9.0	5	5	828
				1348	Pipe	1		1.22	Manila Bay	MHST	11.34	1	3	0.28	7.0	6.2	5.3	4.7	5	5	375

Note

1) Dimensions are basically based uopn SEDLMM database (2000).
2) PSTL: Pump Start Level, MHST: Mean High Spring Tide
3) *1: based upon inventory maps provided by MMDA
4) *A: Declogging is not proposed in the master plan.

Judgment

1,2,3,4,5 = The discharge capacity and probable discharge
1 = The capacity is more than Q10.
2 = The capacity is Q10 - Q5.
3 = The capacity is Q5 - Q3.
4 = The capacity is Q3 - Q2.
5 = The capacity is less than Q2.

(3) Discharge Capacity

Drainage network in the study area is very complex and flow direction varies with time in some places. It is necessary to employ hydrodynamic network model to evaluate such a complex system accurately. However, a simple estimation of discharge capacity with some assumptions is also useful to get a fundamental idea for understanding the existing drainage system. In this section, the results of the estimated discharge capacity for esteros/creeks and drainage mains are summarized.

1) Estero/Creek

The following are assumed to estimate discharge capacity for an estero/creek

- Uniform flow
- Bankfull flow
- Resistance law: Manning equation
- Manning's coefficient: 0.030 (Existing condition), 0.025 (Improved condition)
- Energy slope: Average bed slope or planned bed slope

2) Drainage Main

The discharge capacity for a drainage main is determined as the discharge without overflow at any manholes along the drainage main. To estimate it, pressure flow is assumed in the present study, because when large flood comes, the water level becomes almost equal to bank elevation in esteros/creeks. In such situation, pressure flow in drainage main would occur.

The water level at downstream end of drainage main is assumed as follows.

- Manila Bay: Mean High Spring Tide Level (11.34m)
- Estero/Creek: Top level of drainage main
- Drainage Main: Top level of drainage main
- Pumping Station: Pump start level

The following is also assumed.

- Resistance law: Manning equation
- Manning's coefficient: 0.018 (Existing condition), 0.015 (Improved condition)

The estimated discharge capacities for both original condition without deposition and condition with deposition in 2000 are summarized in *Table E.4.23*.

3) Probable Peak Discharge and Discharge Capacity

To evaluate the existing discharge capacity, probable peak discharges for several observation points of esteros/creeks and drainage mains have been estimated. Runoff coefficient based on the future expected landuse was applied. Flow direction was assumed based on mainly originally planned pump drainage basins. Rational method has been applied to estimate probable peak discharge. Time of concentration has been given by summation of time of flow and time of inlet. The time of flow was estimated assuming uniform and bankfull flow against improved or estimated original condition of esteros/creeks and drainage mains. The time of inlet is estimated based upon assumed flow path within a sub-basin. It is noted that the same methodology to calculate time of concentration is applied for hydrodynamic modeling by MOUSE. *Figure E.4.16* shows the location of observation points for estimating probable peak discharges. The estimated probable peak discharges for several observation points for the existing condition are summarized in *Table E.4.24*. The time of flow and inlet for each reach basin and matrix to calculate contributing reach basin for the discharge observation points are summarized in *Annex E.2*.

Figure E.4.17 shows the existing discharge capacity compared to probable peak discharge. Many channels have the capacity less than 2-years return period peak discharge. The main reason for this is the reduction of cross-sectional area due to heavily accumulated bottom deposits. It is noted that the existence of the informal settlers within channels as obstacles for water flow has not been taken into account directly in this analysis. However, if it is considered, the discharge capacity becomes smaller, although it is difficult to analyze quantitatively. The important finding here is that the reduction of cross-sectional area due to heavily accumulated bottom deposits is already enough to reduce the discharge capacity significantly.

(4) Effect of Dredging and Declogging

Based upon available previous reports and existing observed cross-sectional shapes, the original bed levels for each estero/creek have been estimated. The bed levels to be recovered are then set by considering the connections of each channel. The bed level setting is categorized into the following:

- Original: The bed level is set by following the original plan shown in the previous report.
- Modified: The bed level is set by modifying the original plan (basically higher than the bed level of the original plan).
- New: The bed level is set by estimating the original bed level based on the existing observed cross-sectional shape and connections between channels.
- No: The bed level is kept with existing condition.

The original bank location was estimated using the surveyed cross-sectional shape of the channels. The width of the channel to be dredged is then set using the estimated bank location. The longitudinal profiles of the esteros/creeks are shown in *Annex E.1*.

The above-mentioned categories for the bed levels and estimated dredging volumes for each channel division are summarized in *Table E.4.25*, together with estimated number of structures within esteros. Total volumes to be dredged from esteros/creeks are estimated at about 840,000 m^3. On the other hand, estimated declogging volume for each drainage main is shown in *Table E.4.23*. Total volumes to be declogged from drainage mains are estimated at about 80,000 m^3.

By conducting the dredging of esteros/creeks and declogging of drainage mains, the discharge capacity can be recovered as shown in *Figure E.4.18*. Discharge capacity for almost all of the esteros directly connecting to pumping stations will recover to the capacity of more than 10-year return period peak discharge. Many drainage mains have the capacity of more than 3-year return period peak discharge. This result clarifies that dredging and declogging can be significantly effective to regain the channel capacity and consequently to reduce inundation in the core area. However, as can also be seen in *Figure E.4.17*, some drainage mains such as Blumentritt interceptor in north Manila and Zobel-Roxas in South Manila have less capacity still even if declogging is executed. The dredging and declogging are fundamental, but additional work is still required in some places.

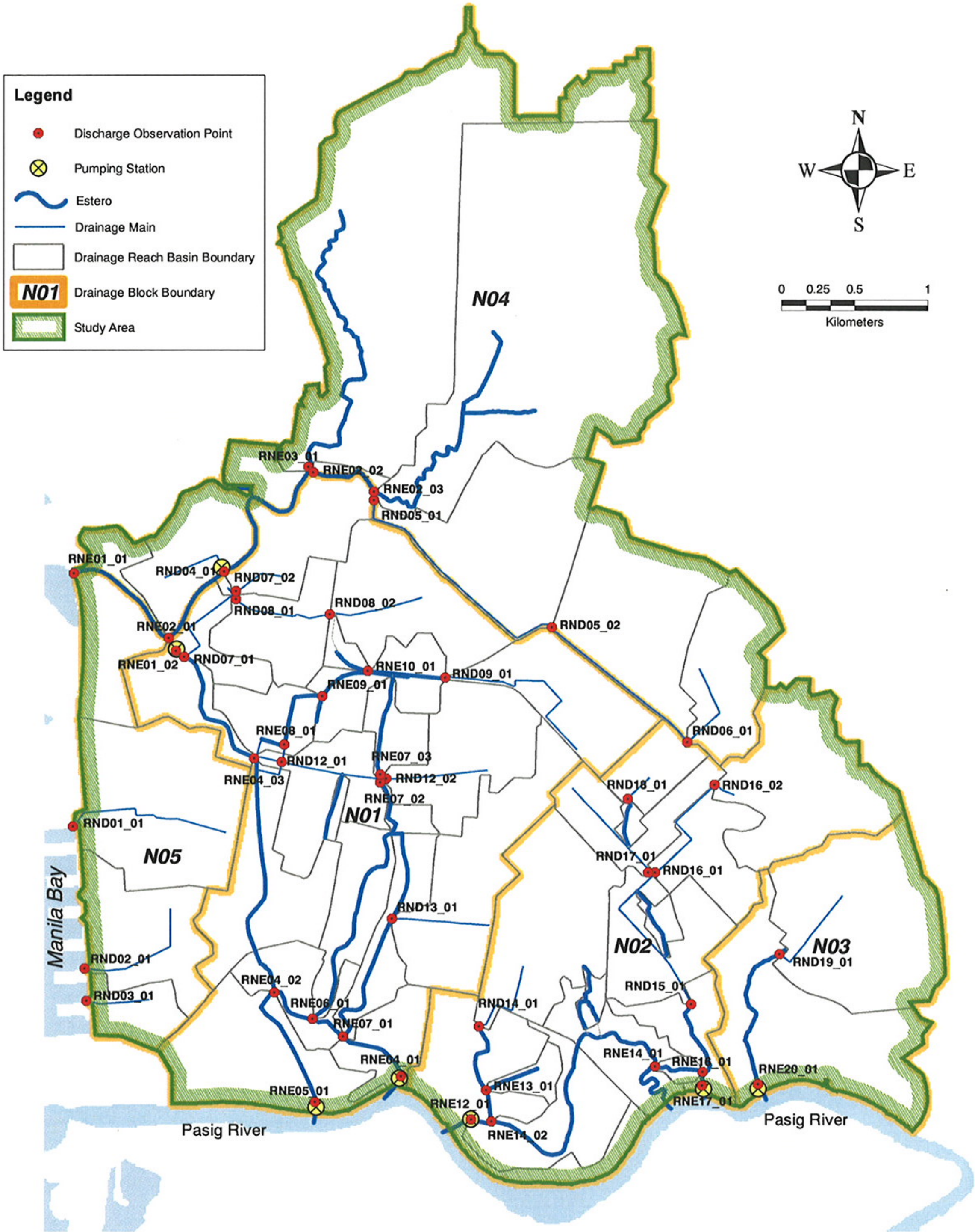


Figure E.4.16 Location of Discharge Observation Points (1/2)

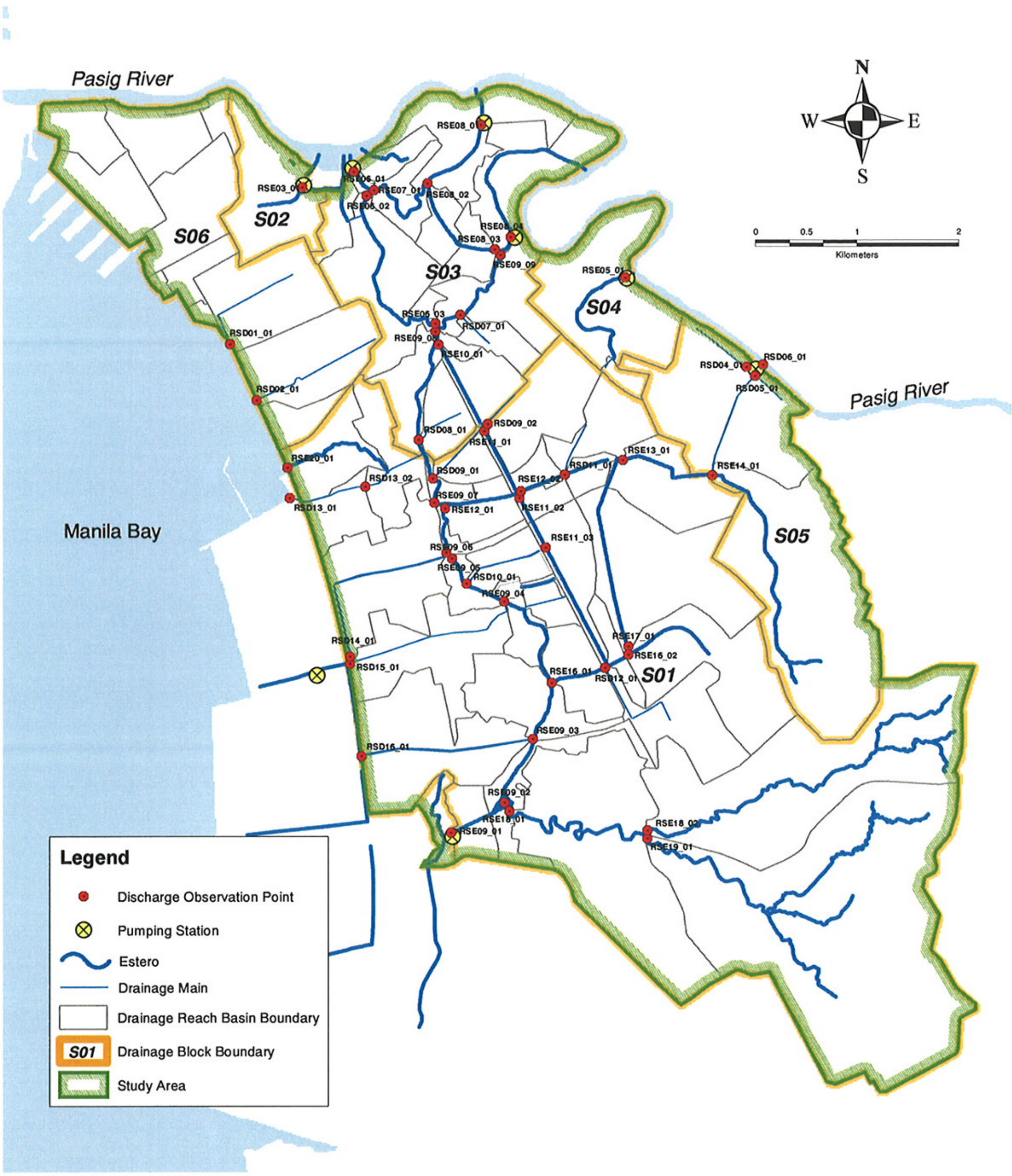


Figure E.4.16 Location of Discharge Observation Points (2/2)

Table E.4.24 Estimated Probable Peak Discharge (1/2)

Block_ID	Basin_ID	WaterWay ID	Observation Point (Reach_ID)	Drainage Area A (km2)	Runoff Coef. C	Time of Concentration T_c (hour)	Areal Reduction Factor	Q10 (m^3/s)	Q5 (m^3/s)	Q3 (m^3/s)	Q2 (m^3/s)	Remarks
N01	N01_01	NE01	RNE01_02	5.693	0.746	1.46	0.98	77.8	67.5	58.3	50.1	Vitas P.S.
N01	N01_01	ND07	RND07_01	1.850	0.752	0.81	0.99	35.4	30.9	26.7	23.2	
N01	N01_01	ND07	RND07_02	0.494	0.785	0.62	1.00	11.4	10.0	8.6	7.5	
N01	N01_01	ND08	RND08_01	1.141	0.737	0.70	0.99	23.0	20.1	17.4	15.2	
N01	N01_01	ND08	RND08_02	0.705	0.744	0.55	0.99	16.1	14.1	12.2	10.6	
N01	N01_01	NE08	RNE08_01	1.282	0.746	1.22	1.00	19.7	17.2	14.8	12.8	
N01	N01_01	NE09	RNE09_01	1.014	0.748	1.10	1.00	16.6	14.4	12.5	10.8	
N01	N01_01	NE10	RNE10_01	0.768	0.747	0.99	1.00	13.3	11.6	10.0	8.7	
N01	N01_01	ND09	RND09_01	0.592	0.739	0.85	1.00	11.0	9.6	8.3	7.2	
N01	N01_01	ND12	RND12_01	1.410	0.695	0.55	1.00	30.6	26.8	23.2	20.2	
N01	N01_01	ND12	RND12_02	0.647	0.641	0.40	1.00	14.9	13.1	11.3	9.8	
N01	N01_01	NE07	RNE07_03	0.189	0.742	0.32	1.00	5.5	4.9	4.2	3.7	
N01	N01_01	NE07	RNE07_02	0.069	0.705	0.26	1.00	2.1	1.8	1.6	1.4	
N01	N01_01	NE04	RNE04_03	3.522	0.736	1.23	1.00	53.4	46.4	40.1	34.6	
N01	N01_02	NE05	RNE05_01	2.562	0.774	1.65	0.99	34.3	29.7	25.7	22.0	Binondo P.S.
N01	N01_02	NE04	RNE04_02	1.766	0.762	1.44	0.99	25.1	21.8	18.9	16.2	
N01	N01_02	NE06	RNE06_01	0.392	0.745	0.41	1.00	10.4	9.1	7.9	6.9	
N01	N01_02	NE07	RNE07_01	1.197	0.765	1.34	1.00	18.0	15.6	13.5	11.6	
N01	N01_02	ND13	RND13_01	0.863	0.768	0.93	1.00	15.8	13.8	11.9	10.3	
N01	N01_03	NE04	RNE04_01	0.296	0.795	0.41	1.00	8.4	7.4	6.3	5.5	Escolta P.S.
N02	N02_01	NE12	RNE12_01	2.293	0.737	1.00	0.99	38.6	33.6	29.1	25.2	Quiapo P.S.
N02	N02_01	NE14	RNE14_02	0.505	0.716	0.38	1.00	13.3	11.6	10.0	8.8	
N02	N02_01	NE13	RNE13_01	0.100	0.709	0.26	1.00	3.0	2.7	2.3	2.0	
N02	N02_01	ND14	RND14_01	0.926	0.741	0.81	1.00	17.6	15.4	13.3	11.6	
N02	N02_02	NE17	RNE17_01	3.284	0.715	1.39	0.99	44.8	38.9	33.6	29.0	Aviles P.S.
N02	N02_02	NE16	RNE16_01	0.451	0.743	0.58	1.00	10.2	8.9	7.7	6.7	
N02	N02_02	NE14	RNE14_01	0.410	0.741	0.48	1.00	10.1	8.9	7.6	6.7	
N02	N02_02	ND15	RND15_01	2.550	0.709	1.26	0.99	36.4	31.6	27.3	23.6	
N02	N02_02	ND16	RND16_01	1.312	0.688	0.91	1.00	21.9	19.1	16.5	14.3	
N02	N02_02	ND16	RND16_02	0.943	0.688	0.70	1.00	17.9	15.7	13.5	11.8	
N02	N02_02	ND17	RND17_01	0.655	0.738	0.25	1.00	20.9	18.4	15.8	13.8	
N02	N02_02	ND18	RND18_01	0.238	0.743	0.25	1.00	7.6	6.7	5.8	5.0	
N03	N03_01	NE20	RNE20_01	2.370	0.678	0.66	0.99	45.3	39.5	34.2	29.8	Valencia
N03	N03_01	ND19	RND19_01	1.208	0.646	0.50	1.00	25.4	22.2	19.2	16.8	
N04	N04_01	NE01	RNE01_01	15.611	0.710	2.40	0.95	148.4	128.2	110.5	93.8	Est Vitas
N04	N04_01	NE02	RNE02_01	9.781	0.690	1.82	0.96	107.3	92.9	80.2	68.6	
N04	N04_01	NE03	RNE03_01	3.019	0.751	1.44	0.99	42.3	36.7	31.7	27.2	
N04	N04_01	NE02	RNE02_02	6.103	0.648	1.39	0.97	73.7	64.0	55.3	47.6	
N04	N04_01	NE02	RNE02_03	3.444	0.681	1.35	0.99	45.5	39.6	34.2	29.4	
N04	N04_01	ND05	RND05_01	2.620	0.603	1.17	0.99	33.1	28.8	24.9	21.5	
N04	N04_01	ND05	RND05_02	1.563	0.689	0.78	0.99	27.9	24.4	21.1	18.3	
N04	N04_01	ND06	RND06_01	0.579	0.664	0.50	1.00	12.5	10.9	9.5	8.3	
N04	N04_02	ND04	RND04_01	0.494	0.789	0.31	1.00	15.6	13.7	11.8	10.3	Balut P.S.
N05	N05_01	ND01	RND01_01	1.127	0.831	0.60	1.00	28.0	24.5	21.2	18.5	
N05	N05_01	ND02	RND02_01	0.618	0.850	0.31	1.00	20.9	18.4	15.8	13.8	
N05	N05_01	ND03	RND03_01	0.229	0.850	0.30	1.00	7.9	6.9	6.0	5.2	

Note: Observation points are basically located at downstream end of each reach basin.

Table E.4.24 Estimated Probable Peak Discharge (2/2)

Block_ID	Basin_ID	WaterWay ID	Observation Point (Reach_ID)	Drainage Area A (km2)	Runoff Coef. C	Time of Concentration T_c (hour)	Areal Reduction Factor	Q10 (m^3/s)	Q5 (m^3/s)	Q3 (m^3/s)	Q2 (m^3/s)	Remarks
S01	S01_01	SE09	RSE09_01	11.561	0.619	1.24	0.95	139.1	120.9	104.5	90.2	Tripa P.S.
S01	S01_01	SE18	RSE18_01	10.839	0.614	1.13	0.96	138.0	120.1	103.8	89.7	
S01	S01_01	SE18	RSE18_02	2.935	0.646	0.85	0.98	46.8	40.8	35.3	30.6	
S01	S01_01	SE19	RSE19_01	5.401	0.565	0.82	0.97	75.5	65.8	56.9	49.5	
S01	S01_01	SE09	RSE09_02	0.439	0.716	0.57	1.00	9.6	8.4	7.3	6.4	
S01	S01_01	SE09	RSE09_03 (*1)	5.489	0.740	1.81	0.98	65.9	57.1	49.3	42.1	
S01	S01_01	SE16	RSE16_01 (*1)	4.829	0.735	1.61	0.98	61.6	53.5	46.2	39.6	
S01	S01_01	SD12	RSD12_01 (*1)	0.715	0.726	0.59	1.00	15.6	13.7	11.8	10.3	
S01	S01_01	SE16	RSE16_02 (*1)	1.207	0.694	1.21	0.99	17.2	15.0	12.9	11.2	
S01	S01_01	SE17	RSE17_01 (*1)	2.266	0.746	1.54	0.99	30.4	26.4	22.8	19.6	
S01	S01_01	SE13	RSE13_01 (*1)	0.724	0.727	0.35	1.00	20.1	17.6	15.2	13.3	
S01	S01_02	SD14	RSD14_01	4.740	0.740	1.78	0.98	57.5	49.8	43.0	36.8	Buendia
S01	S01_02	SE09	RSE09_06	2.506	0.718	1.41	0.99	34.0	29.5	25.5	22.0	
S01	S01_02	SE09	RSE09_07	1.120	0.720	1.21	1.00	16.8	14.6	12.6	10.9	
S01	S01_02	SD09	RSD09_01	1.007	0.722	0.92	1.00	17.5	15.2	13.2	11.4	
S01	S01_02	SD09	RSD09_02	0.786	0.726	0.77	1.00	15.0	13.1	11.3	9.9	
S01	S01_02	SE12	RSE12_01	1.272	0.719	1.21	1.00	19.0	16.5	14.3	12.3	
S01	S01_02	SE11	RSE11_01	0.042	0.850	0.40	1.00	1.3	1.1	1.0	0.8	
S01	S01_02	SE11	RSE11_02	0.136	0.799	0.32	1.00	4.3	3.7	3.2	2.8	
S01	S01_02	SE12	RSE12_02	0.772	0.704	1.07	1.00	12.1	10.5	9.1	7.8	
S01	S01_02	SD11	RSD11_01	0.488	0.683	0.73	1.00	9.1	7.9	6.8	6.0	
S01	S01_02	SE09	RSE09_05	1.094	0.769	0.87	1.00	20.9	18.2	15.7	13.7	
S01	S01_02	SD10	RSD10_01	0.819	0.768	0.74	1.00	17.0	14.8	12.8	11.1	
S01	S01_02	SE11	RSE11_03	0.499	0.797	0.54	1.00	12.5	10.9	9.4	8.3	
S01	S01_02	SD15	RSD15_01	1.357	0.777	0.77	0.99	27.6	24.1	20.8	18.1	Libertad
S01	S01_02	SE09	RSE09_04	0.351	0.785	0.41	1.00	9.8	8.6	7.4	6.5	
S01	S01_02	SD16	RSD16_01 (*1)	6.869	0.743	2.35	0.97	70.7	61.1	52.7	44.7	EDSA
S01	S01_03	SD13	RSD13_01	0.885	0.724	0.99	1.00	14.8	12.9	11.2	9.7	
S01	S01_03	SD13	RSD13_02	0.528	0.706	0.76	1.00	9.9	8.6	7.5	6.5	
S01	S01_03	SE20	RSE20_01	0.549	0.639	0.58	1.00	10.7	9.4	8.1	7.1	
S02	S02_01	SE03	RSE03_01	0.939	0.668	1.03	1.00	14.2	12.4	10.7	9.3	Balete P.S.
S03	S03_01	SE06	RSE06_01	1.740	0.738	0.72	0.98	34.5	30.1	26.0	22.7	Paco P.S.
S03	S03_01	SE07	RSE07_01	0.299	0.725	0.35	1.00	8.2	7.2	6.2	5.4	
S03	S03_01	SE06	RSE06_02	1.218	0.766	0.68	0.99	25.9	22.6	19.5	17.0	
S03	S03_02	SE08	RSE08_01	1.147	0.628	0.42	0.99	25.2	22.1	19.0	16.6	Pandacan P.S.
S03	S03_02	SE08	RSE08_02	0.233	0.736	0.29	1.00	7.0	6.2	5.3	4.7	
S03	S03_03	SE08	RSE08_04	3.232	0.720	1.61	0.99	40.8	35.4	30.6	26.2	SanAndres P.S.
S03	S03_03	SE08	RSE08_03	0.239	0.747	0.49	1.00	5.9	5.1	4.4	3.9	
S03	S03_03	SE09	RSE09_09	2.124	0.725	1.51	1.00	28.3	24.5	21.2	18.2	
S03	S03_03	SD07	RSD07_01	0.226	0.732	0.54	1.00	5.2	4.5	3.9	3.4	
S03	S03_03	SE06	RSE06_03	0.084	0.830	0.26	1.00	3.0	2.6	2.3	2.0	
S03	S03_03	SE09	RSE09_08	1.146	0.725	1.18	0.99	17.3	15.0	13.0	11.2	
S03	S03_03	SE10	RSE10_01	0.352	0.702	0.71	1.00	6.8	5.9	5.1	4.5	
S03	S03_03	SD08	RSD08_01	0.323	0.715	0.57	1.00	7.1	6.2	5.3	4.7	
S04	S04_01	SE05	RSE05_01	1.569	0.632	0.54	1.00	31.2	27.3	23.6	20.6	Sta. Clara P.S.
S05	S05_01	SD04	RSD04_01	1.002	0.657	0.70	1.00	18.3	15.9	13.8	12.0	Makati P.S.
S05	S05_01	SD05	RSD05_01	0.649	0.715	0.54	1.00	14.6	12.8	11.0	9.6	Makati P.S.
S05	S05_02	SD06	RSD06_01	2.657	0.604	0.93	0.99	38.1	33.2	28.7	24.9	
S05	S05_02	SE14	RSE14_01	2.657	0.604	0.80	0.99	41.2	35.9	31.0	27.0	
S06	S06_01	SD01	RSD01_01	0.932	0.806	0.47	0.99	24.9	21.8	18.8	16.4	
S06	S06_01	SD02	RSD02_01	0.924	0.792	0.52	0.99	23.2	20.4	17.6	15.4	

Note: Observation points are basically located at downstream end of each reach basin.

*Note: *1 Stormwater from these reaches is assumed to be drained through EDSA outfall, considering the existing condition.*

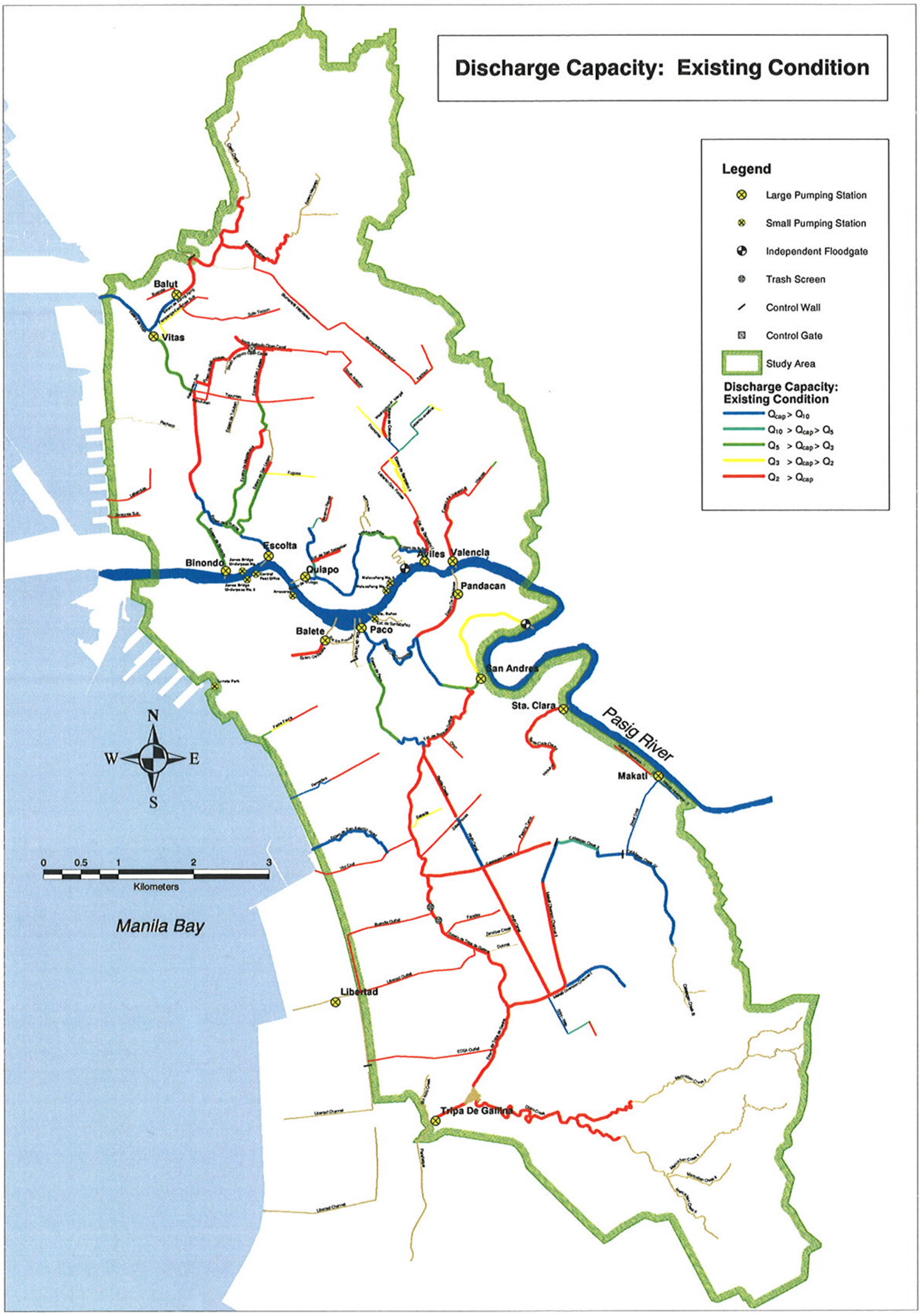


Figure E.4.17 Discharge Capacity of Drainage Channels in Existing Condition

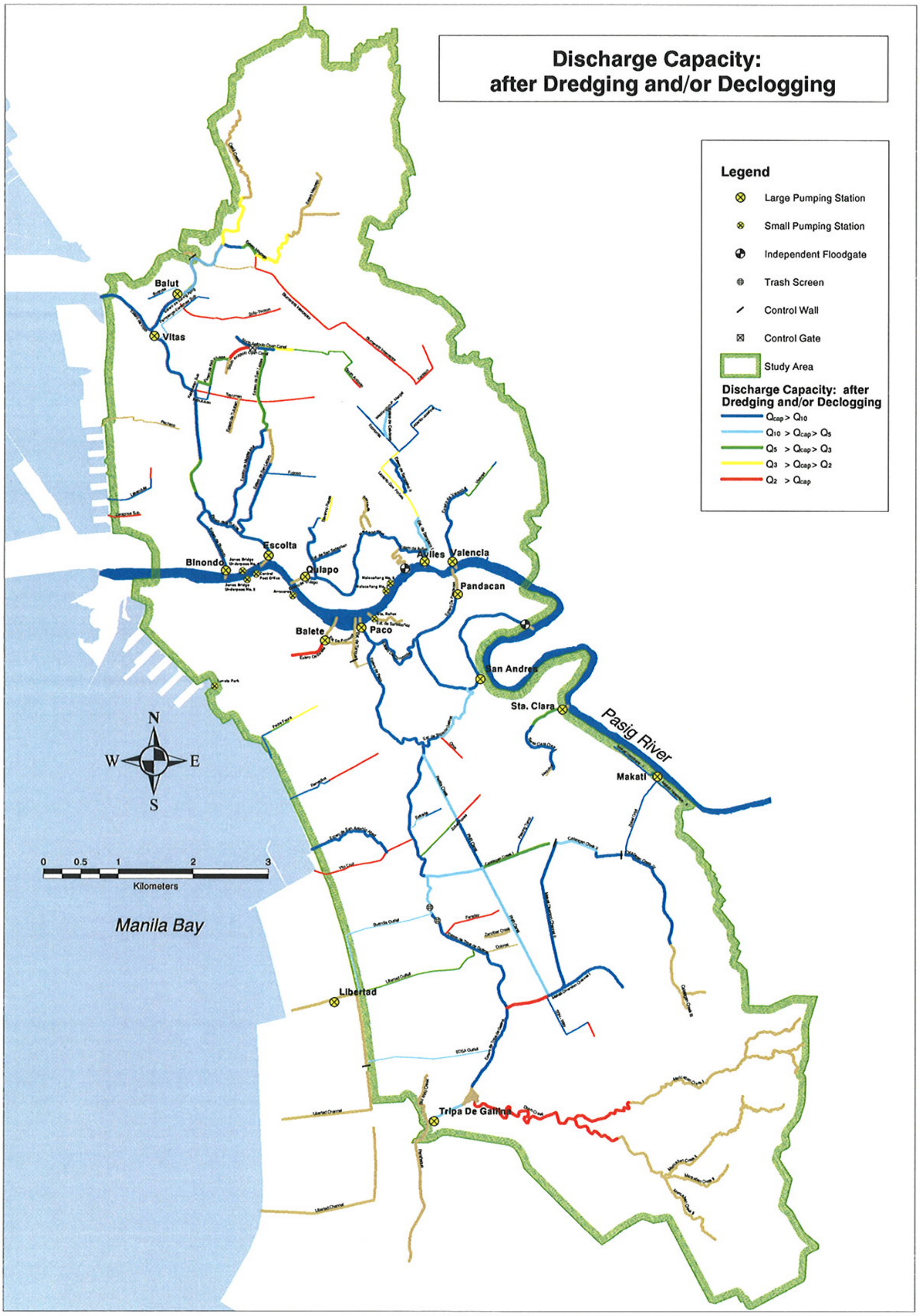


Figure E.4.18 Discharge Capacity of Drainage Channels after Dredging and Declogging

Table E.4.25 Dredging Volume from Estreos/Creeks (1/2)

Estero Code	Name of Estero	Portion	SEC CODE	Length (m)	Reference	Assumed Bed	Dredging Volume (m^3)	Estimated number of bluidings within channel	Judgement Existing	Judgement After Dredging
NE01	Estero De Vitas		NE0101	873	1	MODIFIED	76085	34	1	1
			NE0102	171	1	MODIFIED	800	0	3	1
			NE0103	948	1	MODIFIED	32662	17	3	1
NE02	Estero De Sunog Apog/ Maypajo	1	NE0201	606	1	MODIFIED	27825	0	1	1
			NE0202	1221	1	MODIFIED	63650	37	5	2
		2	NE0203	270	1	MODIFIED	11623	2	5	1
			NE0204	283	1	MODIFIED	2530	26	5	3
			NE0205	813	0	NEW	5772	39	5	4
		-	NE0206	1093	0	NO	0	3	6	6
NE02b1	Estero De Sunog Apog/ Maypajo	-	NE02b1	176	0	NO	0	-	6	6
NE02b2	Estero De Sunog Apog/ Maypajo	-	NE02b2	499	0	NO	0	-	6	6
NE03	Casili Creek		NE0301	901	0	NEW	6025	0	5	4
			NE0302	1474	0	NO	0	0	6	6
NE04	Estero Dela Reina	-	NE0400	172	0	NO	0	-	6	6
		1	NE0401	538	2	ORIGINAL	9853	0	1	1
			NE0402	258	2	ORIGINAL	4281	0	3	1
			NE0403	352	2	ORIGINAL	1927	0	1	1
			NE0404	312	2	ORIGINAL	3692	12	1	1
			NE0405	489	2	ORIGINAL	761	3	5	3
		2	NE0406	897	2	ORIGINAL	10739	97	5	1
NE05	Estero De Binondo	-	NE0500	119	0	NO	0	-	6	6
			NE0501	922	2	ORIGINAL	7310	0	3	1
NE06	Estero De Magdalena		NE0601	846	2	MODIFIED	16970	12	3	1
			NE0602	668	2	MODIFIED	1925	23	5	1
NE07	Estero De San Lazaro		NE0701	1012	2	MODIFIED	27788	31	3	1
			NE0702	178	2	MODIFIED	2923	-	5	1
		-	NE0703	509	2	NO	0	-	6	6
			NE0704	428	0	NEW	2142	-	3	3
			NE0705	708	0	NEW	2130	-	5	3
NE08	Estero De Kabulusan		NE0801	690	2	ORIGINAL	8371	5	5	3
NE09	South Antipolo Open Canal	-	NE0901	182	0	NO	0 (*A)	0	6	6
		-	NE0902	371	0	NEW	1834 (*A)	17	5	5
		-	NE0903	278	0	NEW	1730 (*A)	42	5	1
NE10	North Antipolo Open Canal	-	NE1001	257	0	NEW	2351 (*A)	0	5	1
		-	NE1002	523	0	NEW	2783 (*A)	95	5	4
NE11	Estero De Tutuban	-	NE1101	450	0	NO	0	-	6	6
NE12	Estero De Quiapo	-	NE1200	211	0	NO	0	-	6	6
			NE1201	155	0	NEW	3206	4	1	1
			NE1202	219	0	NEW	4003	10	2	1
			NE1203	529	0	NEW	6855	5	1	1
NE13	Estero De San Sebastian		NE1301	379	0	NEW	1685	5	5	1
NE14	Estero De San Miguel/ Uli Uli		NE1401	830	0	NEW	6045	0	6	6
			NE1402	698	0	NEW	12155	24	3	1
			NE1403	1346	0	NEW	17808	22	1	1
NE15	Estero De Alix	-	NE1501	218	0	NO	0	-	6	6
		-	NE1502	270	0	NO	0	-	6	6
		-	NE1503	165	0	NO	0	-	6	6
NE16	Estero De Aviles		NE1601	345	0	NEW	1783	0	1	1
NE17	Estero De Sampaloc I	-	NE1700	63	0	NO	0	-	6	6
			NE1701	123	2	ORIGINAL	2156	0	3	1
			NE1702	537	2	ORIGINAL	7240	0	5	2
NE18	Estero De Sampaloc II		NE1801	506	0	NEW	4786	1	4	1
NE19	Estero De Calubcob		NE1901	337	0	NEW	1136	4	5	2
NE20	Estero De Valencia	-	NE2000	98	0	NO	0	-	6	6
			NE2001	490	0	NEW	13993	58	5	1
			NE2002	637	0	NEW	4930	72	5	1
Total (North Manila)								700		

Referred previous report

1. Metro Manila Flood Control (II) Project(PH-79), Supporting Data to Main Engineering Report (Vol.1) for Hydraulic Design, Design of Civil Works, Mechanical and Electrical Works and Sanitary Works and Cost Estimates, 1991

2. Metro Manila Drainage System Rehabilitation Project (PH-66), Drainage Improvement Plans of Estero de Vitas and Other Catchment Areas, Final Report, 1986

3. Metro Manila Flood Control (II) Project(PH-79), Drawings for Estero Improvement, 1991

4. The Study on the Updated Drainage Plan for the Libertad Reclamation Area in Pasy City, Metro Manila, 1995

Judgement

1,2,3,4,5,6 = The discharge capacity and probable discharge
1 = The capacity is more than Q10.
2 = The capacity is Q10 - Q5.
3 = The capacity is Q5 - Q3.
4 = The capacity is Q3 - Q2.
5 = The capacity is less than Q2.
6 = Not specified

(Note) *A: Dredging is not proposed in the Master plan.

Table E.4.25 Dredging Volume from Estreos/Creeks (2/2)

Estero Code	Name of Estero	Portion	SEC CODE	Length (m)	Reference	Assumed Bed	Dredging Volume (m^3)	Estimated number of bluldings within channel	Judgement Existing	Judgement After Dredging
SE01	Estero De Provisor		SE0101	1018	0	NO	0	0	6	6
SE02	Estero De Tanque		SE0201	344	0	NO	0	0	6	6
SE03	Estero De Balete		SE0301	550	0	NEW	4601	11	5	5
SE04	Estero De Santebanez		SE0401	518	0	NO	0	4	6	6
SE05	Santa Clara Creek	-	SE0500	95	0	NO	0	-	6	6
			SE0501	487	0	NEW	5685	0	5	3
			SE0502	905	0	NEW	10431	10	5	1
SE06	Estero De Paco	-	SE0600	127	0	NO	0	-	6	6
			SE0601	288	0	NEW	2958	1	1	1
			SE0602	268	0	NEW	3207	0	1	1
			SE0603	1217	0	NEW	11232	209	3	1
			SE0604	499	0	NO	0	68	1	1
SE07	Estero De Concordia		SE0701	1070	0	NEW	24702	0	1	1
SE08	Estero De Pandacan	-	SE0800	351	0	NO	0	0	6	6
		1	SE0801	853	0	NEW	10115	0	5	1
			SE0802	710	0	NEW	6005	25	1	1
			SE0803	366	0	NEW	1915	26	3	1
		2	SE0804	292	3	ORIGINAL	2448	0	3	1
		3	SE0805	1657	0	NEW	7148	1	4	1
		-	SE0899	89	0	NO	0	-	6	6
SE09	Estero de Tripa de Gallina	-	SE0900	100	0	NO	0	-	6	6
		1	SE0901	436	4	MODIFIED	40900	1	5	2
			SE0902	305	4	MODIFIED	34362	20	6	6
			SE0903	575	4	MODIFIED	18337	126	5	1
			SE0904	613	4	MODIFIED	22220	168	5	1
		2	SE0905	887	4	MODIFIED	26670	114	5	1
			SE0906	215	4	MODIFIED	9379	17	5	1
			SE0907	132	4	MODIFIED	3750	22	5	1
			SE0908	281	4	MODIFIED	8586	51	5	1
		3	SE0909	355	4	MODIFIED	11865	49	5	1
			SE0910	533	4	MODIFIED	10184	131	5	2
			SE0911	359	4	MODIFIED	6833	50	5	1
		4	SE0912	269	4	MODIFIED	4882	9	5	1
			SE0913	150	3	ORIGINAL	1698	8	5	1
		5	SE0914	1054	3	ORIGINAL	10421	72	5	1
			SE0915	135	3	ORIGINAL	1615	3	5	1
			SE0916	313	3	ORIGINAL	3832	12	5	1
			SE0917	926	3	ORIGINAL	9378	5	5	2
SE10	Perlita Creek		SE1001	922	0	NEW	3284	12	5	2
SE11	PNR Canal	1	SE1101	731	0	NEW	1533	8	1	1
			SE1102	313	0	NEW	1011	1	5	2
			SE1103	839	0	NEW	2428	2	5	2
		2	SE1104	771	0	NEW	1499	105	5	2
SE12	Calatagan Creek I		SE1201	763	0	NEW	6679	8	5	2
			SE1202	948	0	NEW	6483	0	5	3
SE13	Calatagan Creek II		SE1301	609	0	NO	0	0	2	2
			SE1302	388	0	NO	0	0	1	1
SE14	Calatagan Creek III		SE1401	1031	0	NO	0	0	1	1
			SE1402	504	0	NO	0	0	1	1
			SE1403	1023	0	NO	0	0	6	6
SE14b1	Calatagan Creek III		SE14b1	217	0	NO	0	-	6	6
SE15	Zanzibar Creek		SE1501	329	0	NO	0	-	6	6
SE16	Makati Diversion Channel I		SE1601	549	0	NEW	6818	0	5	5
			SE1602	265	0	NEW	4349	43	5	1
		-	SE1603	980	0	NO	0	0	1	1
SE17	Makati Diverson Channel II		SE1701	607	0	NEW	14958	0	5	1
			SE1702	838	0	NEW	10535	0	5	1
			SE1703	550	0	NEW	2810	0	1	1
SE18	Dilain Creek/ Maricaban Creek I		SE1801	115	0		0	-	6	6
			SE1802	2151	0	NEW	45823	9	5	5
			SE1803	478	0	NEW	0	0	5	5
		-	SE1804	492	0	NO	0	15	5	5
			SE1805	3086	0	NO	0	-	6	6
SE18b1	Dilain Creek/ Maricaban Creek I	-	SE18b1	987	0	NO	0	-	6	6
SE18b2	Dilain Creek/ Maricaban Creek I	-	SE18b2	395	0	NO	0	-	6	6
SE19	Maricaban Creek II	-	SE1901	759	0	NO	0	0	5	5
			SE1902	3462	0	NO	0	-	6	6
SE19b1	Maricaban Creek II	-	SE19b1	1080	0	NO	0	-	6	6
SE19b2	Maricaban Creek II	-	SE19b2	1253	0	NO	0	-	6	6
SE19b3	Maricaban Creek II	-	SE91b3	242	0	NO	0	-	1	1
SE20	Estero de San Antonio Abad	-	SE2001	364	0	NO	0	0	1	1
			SE2002	612	0	NO	0	0	1	1
			SE2003	757	0	NO	0	0	6	6
SE21	Libertad Channel	-	SE2100	177	0	NO	0	-	6	6
			SE2101	914	0	NO	0	-	6	6
			SE2102	1691	0	NO	0	-	6	6
SE21b1	Libertad Channel	-	SE21b1	2486	0	NO	0	-	6	6
SE21b2	Libertad Channel	-	SE21b2	725	0	NO	0	-	6	6
SE22	Sto Ni· Creek	-	SE2201	168	0	NO	0	-	6	6
SE99	Paranaque	-	SE9901	1994	0	NO	0	-	6	6
Total (South Manila)								1412		

Referred previous report

1. *Metro Manila Flood Control (II) Project(PH-79), Supporting Data to Main Engineering Report (Vol.1) for Hydraulic Design, Design of Civil Works, Mechanical and Electrical Works and Sanitary Works and Cost Estimates, 1991*

2. *Metro Manila Drainage System Rehabilitation Project (PH-66), Drainage Improvement Plans of Estero de Vitas and Other Catchment Areas, Final Report, 1986*

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E.4.5 NECESSITY OF ADDITIONAL WORK

As have shown in *Chapter E.4.4*, dredging of esteros/creeks and declogging of drainage mains are significantly effective to recover the original function of drainage system in the core area. However, some additional works will be required to improve the inundation condition, especially in severely inundated areas. There are two notable regional inundation areas, one in Aviles, Sampaloc area in North Manila, and the other, San Isidro, San Antonio and Pio del Pilar area in South Manila.

Major causes of the regional inundation in North Manila are assumed as follows:

- Storm water coming from a hilly area in Quezon City is not intercepted by the present drainage system of Blumentritt Interceptor and consequently flows down into the upper catchment of Quiapo-Aviles drainage block.
- Improper function of inlet facilities of existing upper Blumentritt Interceptor due to accumulation of bottom deposits drainage gutter
- Lack of channel flow capacity of Blumentritt interceptor
- Clogging of outlet of Blumentritt interceptor due to accumulation of bottom deposits in the Estero de Maypajo.

Discharge capacity of Blumentritt interceptor now is almost zero. Almost all of stormwater in the drainage area of Blumentritt interceptor can thereby enter the upper catchment of Quiapo-Aviles drainage block. This means that the actual drainage area for Quiapo-Aviles drainage block is much larger than the original plan. Consequently, depth and duration of inundation are also considerably deep and long in the low-lying area of this block. Even if declogging is executed, the discharge capacity of Blumentritt interceptor is still less than the capacity of 2-year return period peak discharge. An additional drainage will be required to keep the function of the interceptor and to prevent overflowing together with some remedial works for existing Blumentritt interceptor.

Major causes of the regional inundation in South Manila are assumed as follows:

- Lack of channel flow capacities of existing connection channels between Calatagan Creek I, PNR Canal, Zobel-Roxas, Makati diversion channel and Estero de Tripa de Gallina due to accumulation of bottom deposits and encroachment of informal settlers
- Lack of connection channels (PNR and South Super Highway as flow barrier)
- Lack of channel flow capacity of Estero de Tripa de Gallina due to accumulation of bottom deposits and encroachment of informal settlers

Main drainage facilities to Manila Bay in this area are drainage pumping stations of Libertad and Tripa de Gallina. However, these pumping stations are not fully operating in the inundation period due to lack of flow capacities of connection or approaching channels, especially at Tripa de Gallina pumping station. Compared with installed drainage pump capacities, flow capacity of the connection channel to Estero de Tripa de Gallina is considerably small. In addition to dredging and declogging, additional works to improve flow capacity for connecting channels to Estero de Tripa de Gallina will be required.

There are some other necessary additional works. These are further discussed in *Chapter E.5*.

E.4.6 PROBLEMS AND CONSTRAINTS IN THE DRAINAGE SECTOR

(1) General

The present drainage system in the core area has been constructed and improved so far. A well-considered system was developed with countless drainage channels of esteros, drainage mains and laterals. Before expansion of urbanization progressed in the last 2 to 3 decades, it was supposed that the drainage system was functioning and consequently, the face of Metropolitan Manila would show open space of water surface and green. It is observed that such valuable drainage channels and facilities are no longer working properly due to illegal activities, encroachment of informal settlers, lack of integrated operation and maintenance system in combination with resident's participation, etc. In this section, problems and constraints in the drainage sector are summarized.

(2) Problems and Constraints

Problems and constraints are categorized into the following 3 aspects of structural, non-structural, and supporting system.

1) Structural Aspect

The existing 15 large drainage pumping stations and 8 small drainage pumping stations are working significantly effective in improving drainage situation in the core area of Metropolitan Manila under the administration of MMDA. Also daily operation and maintenance of pump equipment are well being made. However, 10 pumping stations have being operated nearly 30 years since their constructions. Therefore, mechanical superannuating of pump equipment and its appurtenant facilities has been progressed in some pumping stations. Generally, an economic life of pump equipment and appurtenant facilities is considered to be 20 to 25 years. In this sense, mechanical superannuation of pumping stations is one of the remarkable problems. Also spare parts are out of stock due to stop of production. It can be said that the same problems for the other pumping stations will be coming up in the next 10 years.

In the existing countless drainage channels, it can be generally said that original functions of the respective channels are not demonstrated due to various illegal social activities of dumping of solid waste, encroachment of informal settlers, lack of public awareness, various constraints and limitation for daily operation and maintenance, and budget, etc. Channel flow capacities are considerably decreased compared with original design conditions. Declogging and dredging of the channels are needed.

For the regional inundation areas, basic facilities to collect and drain storm water are in shortage against the respective areas in question. In this regard, it is indispensable to carry out additional structural countermeasures.

2) Non-structural Aspect (Floodplain Management)

The non-structure aspect (measures) aims to reduce damageable objects or properties in the inundation-prone areas or to lower vulnerability against repeating disasters by application of the respective systems of floodplain management, disaster preparedness, flood forecasting and warning, etc, and by means of resettlement of informal settlers residing in the drainage channels, etc., supported by legislation and establishment of consensus among the people and the authorities concerned.

Existing systems of EFCOS and Inter-agencies Floodplain Management are available for flood forecasting and warning, and floodplain management in the core area. Also, Disaster Management System for disaster preparedness is undertaken by Disaster Coordination Committees of National and Regional levels as well as City, Municipality and Barangay levels, and special arrangement of funding allotment is available at the emergency case. These existing systems under government services are applicable to floodplain management as non-structural measures in the core area of Metropolitan Manila.

Meantime, urbanization in the core area has been highly progressed. Open and green spaces including swamps and ponds have been converted into commercial and business complexes. Due to such urbanization, stormwater retention capacity in the core area is decreasing. Also infiltration capacity to underground is remarkably decreasing because of asphalting of ground surface. As a result, runoff coefficient of storm water is still increasing. In this sense, some countermeasures to lower runoff coefficient or to retard storm water temporally (stormwater retention facilities and permeable pavement) are strongly needed in connection with urban development planning in view of effective utilization of present drainage systems and sustainable floodplain management in the core area.

3) Supporting Aspect

In order to sustain the structural and non-structural aspects in effective condition, a setup of powerful supporting system is indispensable. In this regard, the existing supporting system is insufficient at present and for the future. Therefore, the supporting system in this study consists of social education to improve illegal activities of solid waste dumping and encroachment of informal settlers, minimum-scale resettlement to secure necessary flow area of drainage channels, proper operation and maintenance system including resident’s participation, funding system to sustain all related activities of drainage improvement, etc.