APPENDIX 5.1_ENVIRONMENTAL LOADS AND COSTS OF SEWAGE COLLECTION SYSTEMS (CASE STUDY OF AREA A)

1. Environmental Loads of Collection System

Pollution load on public water body at the time of wet weather from separate sewer system or combined sewer system is studied below, which is based on Japanese guideline of planning and design of sewerage facilities.

(1) Treatment Ratio based on Pollutant Loads in Philippine Technical Document (same way with assumption in IM4D)

Table A5.1.1 Pollutant Rates of Basic Environmental Load Parameters

Item	BOD Pollution Rate (g/person/day)	NH4 Pollution Rate (g/person/day)	NO3 Pollution Rate (g/person/day)	TP Pollution Rate (g/person/day)
Night soil	20	7	0	0.8
Gray water	10	1	1	1.5
Total	30	8	1	2.3

Source: Total Pollutant Loading Study in the Laguna de Bay–Pasig River–Manila Bay Watershed, Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) 2013, ISBN 978-971-812-028-6.

Table A5.1.2 BOD Generation Amount (Area A)

Item		Year			
		2015	2022	2030	2045
Population (person)	Agdao	102,267	106,482	111,300	124,800
	Poblacion (+ Part of Bucana)	188,235	198,927	211,145	244,983
	Total	290,502	305,409	322,445	369,783
BOD Generation amount (kg/day)		8,715	9,162	**9,673**	**11,093**

Source: JICA Survey Team

Table A5.1.3 BOD Discharge Amount and Treated/Untreated Ratios (Area A)

Year		2030			2045			Treatment Ratio	
No.	Option	Generation (kg/day)	Removed/Decomposed (kg/day)	Discharged (kg/day)	Generation (kg/day)	Removed/Decomposed (kg/day)	Discharged (kg/day)	Treated Ratio(%)	Untreated Ratio(%)
1	Intercepter Sewer & STP	9,673	0 6,732	2,193 748	11,093	0 7,721	2,515 858	69.6%	30.4%
2	Combined Sewer & STP	9,673	0 7,390	1,462 821	11,093	0 8,475	1,677 942	76.4%	23.6%
3	Separated Sewer & STP	9,673	0 8,340	406 927	11,093	0 9,565	466 1,063	86.2%	13.8%

(2) Trial Calculation of Pollution Loads based on Japanese Guideline

i) Pollution Load from Separate Sewer System

a) Unit BOD load of rainwater flowing to public water body through land: 100 kg/year/ha

b) Area of the Area-A: 1,700 ha

Total BOD load at the time of wet weather: 100 (kg/year/ha) x 1,700 (ha) = 170,000 kg/year

ii) Pollution Load from Combined Sewer System

a) Unit BOD load of combined sewage overflow to public water body in a city of Japan: 200 kg/year/ha

b) Approximate number of rainy days of Japan: 100 days

c) Supposed number of rainy days of Davao City: 180 days (1/2 of a year)

d) Unit BOD load of combined sewer overflow to public water body in Davao City: a) x c) / b) = 360 kg/year/ha

e) Area of the Area-A: 1,700 ha

Total BOD load at the time of wet weather: 360 (kg/year/ha) x 1,700 (ha) = 612,000 kg/year

iii) Pollution Load from Interceptor Sewer System

a) Unit BOD load of combined sewage overflow to public water body in a city of Japan: 200 kg/year/ha

b) Approximate number of rainy days of Japan: 100 days

c) Supposed number of rainy days of Davao City: 180 days (1/2 of a year)

*No. of days with rainy record in 2018 in Davao: 188 days

d) Additional BOD load from combined sewer system: 30%

Untreated ratio of interceptor, combined sewer: 30.4% : 23.6% (Table A5.1.3) = 129 : 100

*1.3 times BOD is discharged from interceptor sewer (CSO chamber) than one of ordinal combined sewer. (due to clogging of interception point, more sedimentation in drains)

e) Unit BOD load of un-intercepted sewage to public water body in Davao City: 360 kg/year/ha x 1.3 = 470 kg/year/ha

f) Area of the Area-A: 1,700 ha

Total BOD load at the time of wet weather: 470 (kg/year/ha) x 1,700 (ha) = 796,000 kg/year

iv) Comparison

The pollution loads discharged from each collection system can be summarized as follows;

Table A5.1.4 Estimated Pollution Load from Wastewater Collection Systems

Wastewater Collection System	Separate Sewer System	Combined Sewer System	Interceptor System
Pollution load (BOD) to public water body	170,000 kg/year	612,000 kg/year	796,000 kg/year

Source: JICA Survey Team

Based on the above trial calculation, pollution load on public water body at the time of wet weather from combined sewer system is more than 3 times of pollution load from separate sewer system.

2. Comparison of Sewer Network Development Costs

As case study, the trial calculation of construction cost of sewer network for the most prioritized Area-A is executed on the assumptions shown below.

Table A5.1.5 Assumption of Trial Calculation of Construction Cost of Sewer Network of Area-A (Case Study)

Item	Separate Sewer System	Combined Sewer System (Interceptor & Combined Sewer)
Common	1) Total area of the Area-A is 1,700 ha. 2) Total length of public road in the Area-A is 170km. 3) Sanitary sewer is necessary to be installed along every public road. 4) 50% of existing lateral drains do not have enough capacities and combined sewer is necessary to be installed along these existing drainage channels. 5) All pipes will be installed by open-cut method.	
Assumptions to calculate the design flow and pipe diameter	1) Daily maximum wastewater generated in whole Area-A is 100,000m^3/d. 2) The peak factor of wastewater generation (Hourly maximum /Daily maximum) is 1.5.	1) Runoff coefficient of Area-A is 0.7, and target rainfall flowing through combined sewer is 50mm/hr. 2) Interceptors don't flow the wastewater diluted by rain water, which means only 1Q wastewater is collected into interceptor.
Target structures	1) Sanitary sewer: 170km (D200mm: 90km, D300mm: 30km, D400mm: 10km, D500mm: 15km, D800mm: 15km, D1200mm: 5km, D1500mm: 3km, D1800mm: 2km) 2) House connection: 70,000 households	1) Interceptor trunk line: 7km (D1500 5km, D1800: 2km) 2) Interceptor: 13km (D1000mm: 8km, D1200mm: 5km) 3) Newly-installed combined sewer: 75km (D300mm: 20km, D400mm: 10km, D500mm: 10km, D600mm: 10km, D700mm: 10km, D800mm: 10km, D900mm: 5km) 4) CSO chamber: 260 nos. (It is assumed that the installation of CSO is required every 50m of interceptor.) 5) House connection: 35,000 households (1/2 of the case of separate sewer system)

Source: JICA Survey Team

Preliminary construction cost of each case is calculated as below, which is based on the unit prices of past sewerage project in Philippines.

Table A5.1.6 Result on Trial Calculation of Construction Cost for Sewer Network in Area-A (Case Study)

Separate Sewer System	Combined Sewer System (mainly Interceptor System)	Combined Sewer System
1) Sanitary sewer: PHP 12.1 billion 2) House connection: PHP 1.4 billion Total: PHP 13.5 billion (120)	1) Interceptor and combined sewer: PHP 10.1 billion 2) CSO chamber: PHP 0.1 billion 3) House connection: PHP 0.7 billion Total: PHP 10.9 billion (100)	1) Combined sewer: PHP 15 billion and more 2) Stormwater inlets and CSO chamber: PHP 0.2 billion 3) House connection: PHP 1.4 billion Total: PHP 17 billion and more (More than 150)

Note: Cost above are preliminary estimation only for comparison
The quantities are based on ones in Table 5.3.4. The unit prices are based on JICA Data Collection Survey for Sewerage Development in Metro Manila West in 2016.
The base costs were adjusted with price escalation (2016: 108.36, 2019: 121.76)
Source: JICA Survey Team

Appendix 5.2 Assumed Scale and Cost of Sewage Collection Facilities in each Area for Comparison between Combined Sewer and Separate Sewer Systems (Reference)

Table 1: Combined Sewer (Interceptor) Development Case

Area	Interceptor			Combined Sewer		House Connection		Drain Cover and Ditch Improvement		Development Cost	Future Retention Pipe (Improvement)		Total Cost
	Assumed Length	Maximum Diameter	Assumed Cost	Total Length	Assumed Cost	Number of houses	Assumed Cost	Length	Assumed Cost		Length	Assumed Cost	
	(km)	(mm)	(Php million)	(km)	(Php million)	(nos)	(Php million)	(km)	(Php million)	(Php million)	(km)	(Php million)	(Php million)
Area A	12.3	1500	1,694	123.5	7,048	77,360	1,547	49.4	494	10,783	27.5	11,808	22,591
Area B	14.6	1350	1,276	30.5	3,616	69,897	1,398	30.5	305	6,594	24.9	10,712	17,306
Area C	22.8	1800	2,744	83.1	8,232	132,980	2,660	55.4	554	14,190	45.6	19,598	33,788
Area D	20.5	1650	2,234	65.7	6,790	107,831	2,157	43.8	438	11,619	38.5	16,555	28,174
Area E	17.0	1200	1,311	15.5	2,729	46,676	934	15.5	155	5,128	16.4	7,060	12,189
Area F	19.6	1500	1,925	16.9	4,434	91,908	1,838	33.8	338	8,535	32.6	13,999	22,534
Total	107.0		11,183	335.2	32,850	526,652	10,533	228.3	2,283	56,850	185.4	79,731	136,581

Note: 1. Combined sewer is for the areas with insufficient capacity drains and without drains
2. The sewer development costs include manholes and intermediate pumping stations

Table 2: Separate Sewer Development Case

Area	Trunk Sewer			Lateral Sewer		House Connection		Total Cost
	Assumed Length	Maximum Diameter	Assumed Cost	Total Length	Assumed Cost	Number of houses	Assumed Cost	
	(km)	(mm)	(Php million)	(km)	(Php million)	(nos)	(Php million)	(Php million)
Area A	12.3	1500	1,130	288	11,206	77,360	1,547	13,883
Area B	14.6	1350	850	260	10,125	69,897	1,398	12,373
Area C	22.8	1800	1,829	495	19,263	132,980	2,660	23,751
Area D	20.5	1650	1,489	404	15,743	107,831	2,157	19,388
Area E	17.0	1200	874	174	6,761	46,676	934	8,569
Area F	19.6	1500	1,283	342	13,313	91,908	1,838	16,434
Total	107.0		7,455	1,962	76,411	526,652	10,533	94,399

Table 3: Interceptor Sewer Development Cumulative Cost

Area	Work	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
A	Interceptor	565	565	565																																	
	Combined Sewer			881	881	881	881	881	881	881	881																										
	Misc. (drain cover etc.)				99	99	99	99	99																												
	House connection			155	155	155	155	155	155	155	155	155	155																								
	Interceptor sewer improvement																				2,952	2,952	2,952	2,952													
B	Interceptor				425	425	425																														
	Combined Sewer					904	904	904	904																												
	Misc. (drain cover etc.)						102	102	102																												
	House connection						155	155	155	155	155	155	155	155	155																							
	Interceptor sewer improvement																							2,678	2,678	2,678	2,678										
C	Sewer							549	549	549	549	549																									
	Combined Sewer								823	823	823	823	823	823	823	823	823	823																			
	Misc. (drain cover etc.)									139	139	139	139																								
	House connection									156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156											
	Interceptor sewer improvement																										3,920	3,920	3,920	3,920	3,920						
D	Sewer										558	558	558	558																							
	Combined Sewer											849	849	849	849	849	849	849	849																			
	Misc. (drain cover etc.)												110	110	110	110																					
	House connection												154	154	154	154	154	154	154	154	154	154	154	154	154	154	154											
	Interceptor sewer improvement																													2,759	2,759	2,759	2,759	2,759	2,759		
F	Sewer													481	481	481	481																				
	Combined Sewer														887	887	887	887	887																		
	Misc. (drain cover etc.)															113	113	113																			
	House connection															153	153	153	153	153	153	153	153	153	153	153	153										
	Interceptor sewer improvement																																2,800	2,800	2,800	2,800	2,800
E	Sewer																328	328	328	328																	
	Combined Sewer																	910	910	910																	
	Misc. (drain cover etc.)																		155																		
	House connection																		156	156	156	156	156	156													
	Interceptor sewer improvement																																			3,530	3,530
	Total (Php million)	565	565	1,600	1,560	2,464	2,721	2,844	3,667	2,858	3,416	3,384	3,099	3,287	3,615	3,726	3,944	4,373	3,747	1,857	3,571	3,571	3,571	6,249	3,142	3,142	6,751	3,920	3,920	6,679	6,679	2,759	5,559	5,559	5,559	6,330	6,330
	Cummulative (Php million)	565	1,130	2,730	4,290	6,753	9,474	12,318	15,985	18,843	22,260	25,644	28,743	32,030	35,645	39,371	43,316	47,688	51,435	53,292	56,863	60,434	64,006	70,255	73,396	76,538	83,289	87,208	91,128	97,807	104,485	107,245	112,803	118,362	123,921	130,251	136,581

Table 4: Separate Sewer Development Cumulative Cost

Area	Work	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
A	Trunk sewer	565	565																								
	Sanitary (lateral) sewar		1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121															
	House connection			155	155	155	155	155	155	155	155	155	155														
B	Trunk sewer				425	425																					
	Sanitary (lateral) sewar					1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125													
	House connection						155	155	155	155	155	155	155	155	155												
C	Trunk sewer							610	610	610																	
	Sanitary (lateral) sewar								1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204		
	House connection									166	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166		
D	Trunk sewer										496	496	496														
	Sanitary (lateral) sewar											1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124		
	House connection												154	154	154	154	154	154	154	154	154	154	154	154	154	154	
F	Trunk sewer													642	642												
	Sanitary (lateral) sewar														1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210		
	House connection															167	167	167	167	167	167	167	167	167	167	167	
E	Trunk sewer																437	437									
	Sanitary (lateral) sewar																	1,127	1,127	1,127	1,127	1,127	1,127				
	House connection																		156	156	156	156	156	156			
	Total (Php million)	565	1,685	1,275	1,701	2,826	2,556	3,165	4,369	4,535	4,422	5,547	4,580	4,571	4,656	4,026	4,463	5,590	5,309	5,309	5,309	5,309	5,309	4,182	2,822	321	0
	Cummulative (Php million)	565	2,250	3,525	5,226	8,052	10,607	13,773	18,142	22,677	27,099	32,646	37,226	41,797	46,453	50,479	54,942	60,532	65,840	71,149	76,457	81,766	87,074	91,256	94,078	94,399	**94,399**

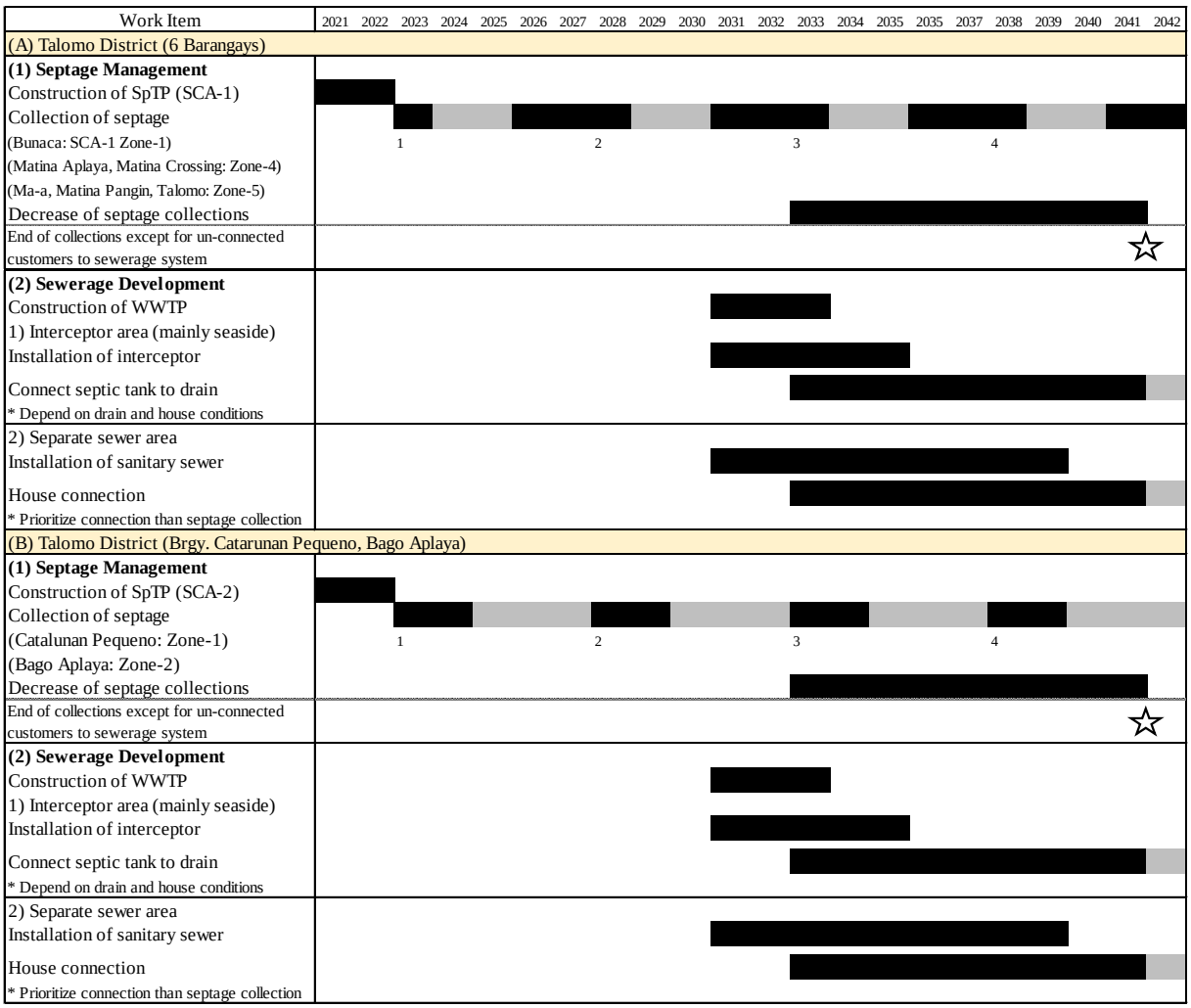
APPENDIX 5.3_COMPREHENSIVE SEWERAGE AND SEPTAGE PROGRAM IN AREA C TO AREA F

1) Area C

The image of comprehensive sewerage and septage management in Area-C is shown in **Table A5.3.1**. Area C has congested areas in seaside and some part of sewer installation would be interceptor sewer system. Due to the large land area and high population density with almost area in future, the total sewer length to be installed is assumed to be quite long.

After 10 years from commencing Septage Management Program the house connections to sewerage system would start in this area. Therefore, the house connections to sewerage system will start after two phases of septage management. If sanitary sewer installations and house connections would finish ideally, the septage collection will finish in 2041 to 2042.

Table A5.3.1 Image of Comprehensive Sewerage and Septage Management in Area C



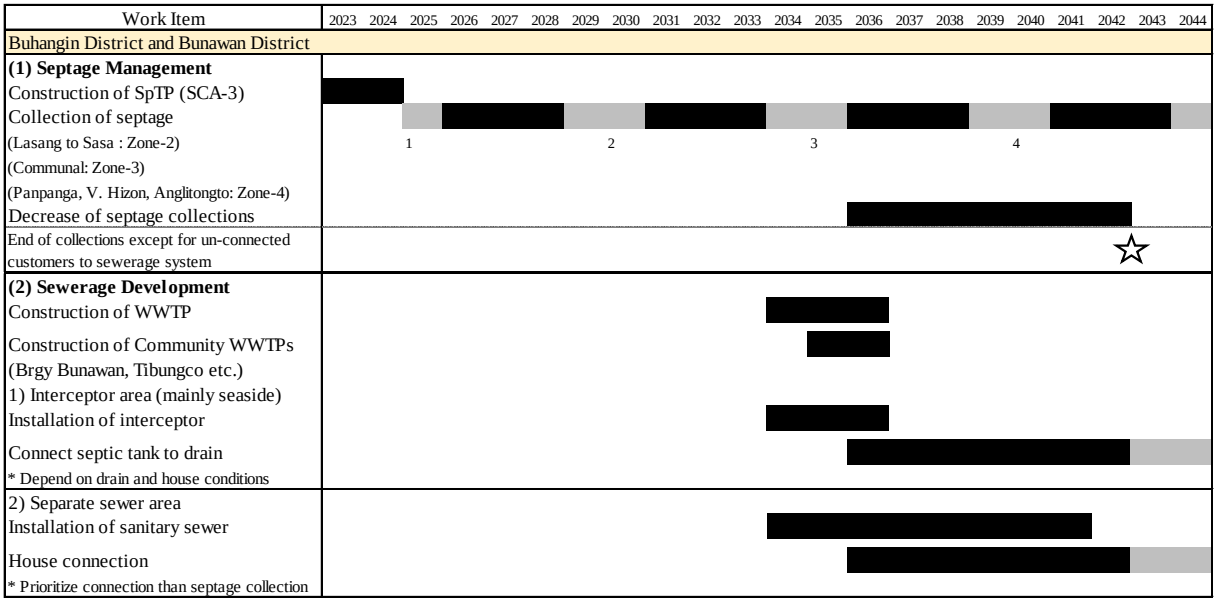
Source: JICA Survey Team

2) Area D

The image of comprehensive sewerage and septage management in Area D is shown in **Table A5.3.2**. Area D also has congested areas in seaside and some part of sewer installation would be interceptor sewer system.

After almost 10 years from commencing Septage Management Program the sewerage development would start in this area. Therefore, the house connections to sewerage system will start after two phases of septage management. If sanitary sewer installations and house connections would finish ideally, the septage collection will finish in 2042 to 2043.

Table A5.3.2 Image of Comprehensive Sewerage and Septage Management in Area D



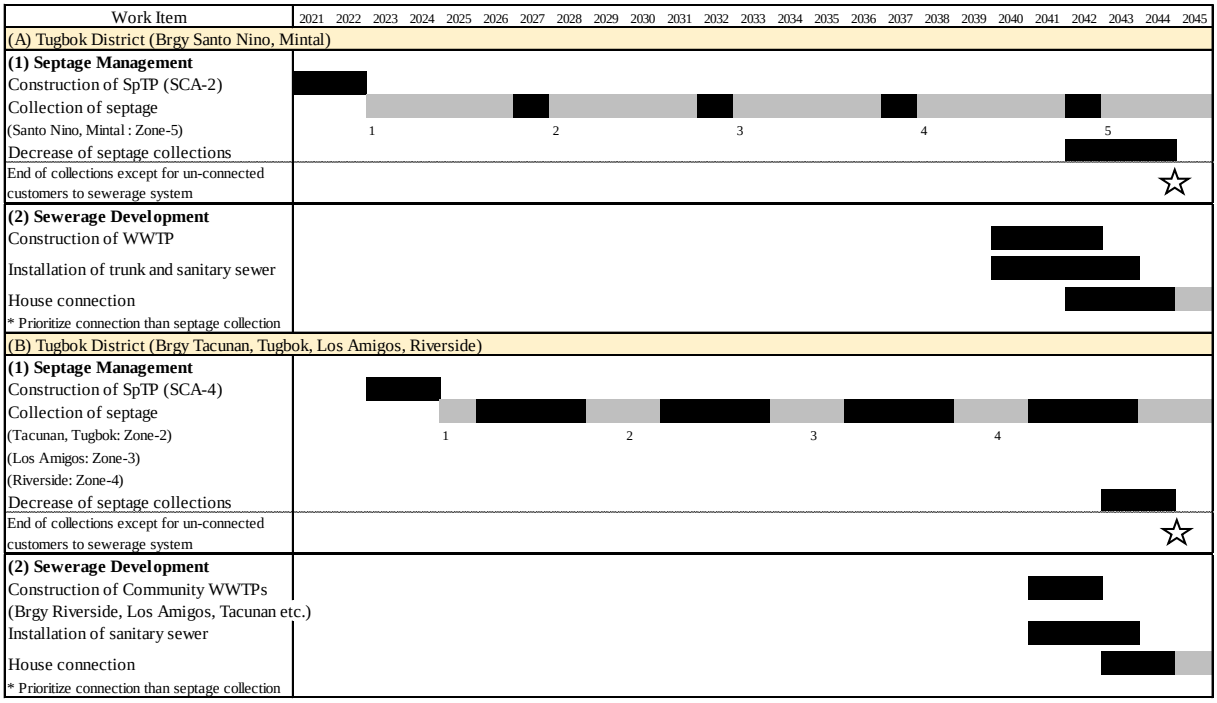
Source: JICA Survey Team

3) Area E

The image of comprehensive sewerage and septage management in Area E is shown in **Table A5.3.3**. Area E is rural area at present and population concentrates beside the main roads. Separate sewer system is appropriate sewage collection method to be developed. Particularly community treatment plants should be constructed in particularly north side barangays from the quite remote colonies in barangays.

After almost 20 years from commencing Septage Management Program the sewerage development would start in this area. Therefore, the house connections to sewerage system will start after almost four phases of septage management. If sanitary sewer installations and house connections would finish ideally, the septage collection will finish in 2044 to 2045. Because sewerage development is much future, to start the community level sewerage system even before the sewerage development program is recommended due to small scale systems in each area.

Table A5.3.3 Image of Comprehensive Sewerage and Septage Management in Area E



Source: JICA Survey Team

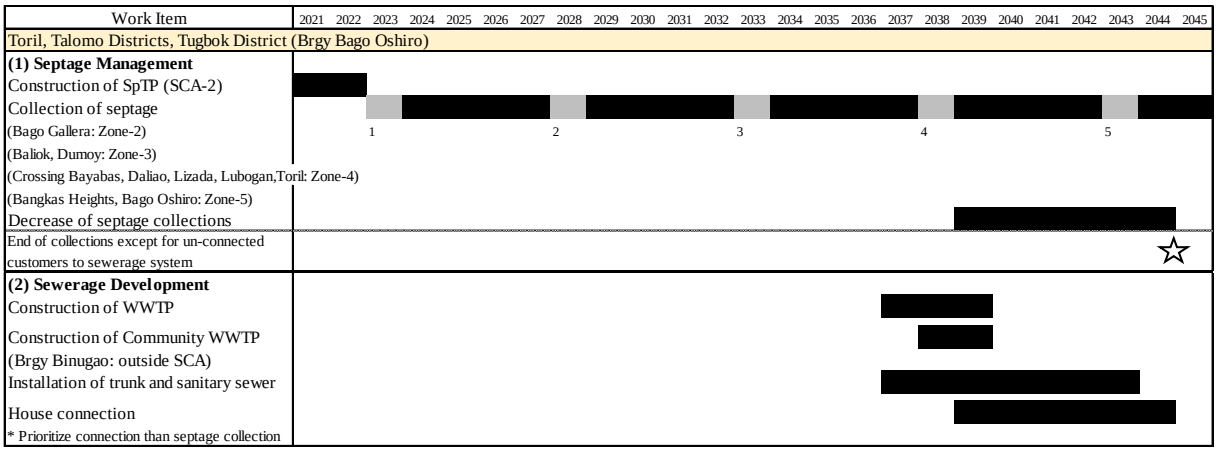
4) Area F

The image of comprehensive sewerage and septage management in Area F is shown in **Table A5.3.4**. Area F has seaside area but compared to Area C and D the congested slum areas are very rare. Many seaside area is newly developed area. In this area, separate sewer system is appropriate sewage collection method to be developed but due to well-developed status of lateral drains with covers in those new areas, the implementing agency can adopt interceptor sewer system also in some points.

Since Barangay Binugao is outside the septage management area, to develop the barangay wide sewerage system in this area is recommended.

After almost 20 years from commencing Septage Management Program the sewerage development would start in this area. Therefore, the house connections to sewerage system will start after three phases of septage management. If sanitary sewer installations and house connections would finish ideally, the septage collection will finish in 2044 to 2045.

Table A5.3.4 Image of Comprehensive Sewerage and Septage Management in Area F



Source: JICA Survey Team

Appendix 5.4 Environmental and Social Conditions in Davao City

1. Pollution

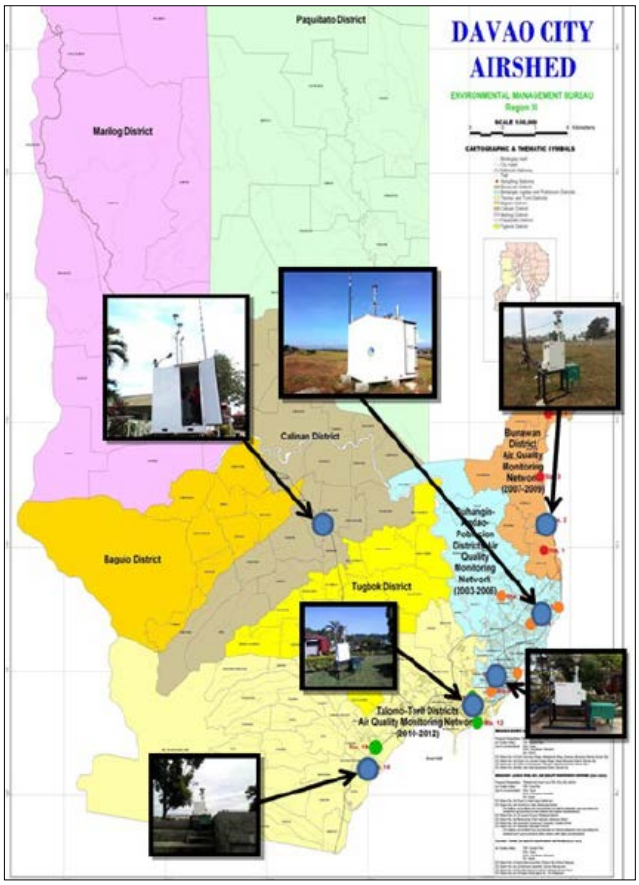
1.1 Air Quality

Table 1.1 and Figure 1.1 shows Davao City Air Quality Monitoring Network.

Table 1.1 Davao City Air Quality Monitoring Network (DC AQMN)

Sampling Sites	Type of Monitoring	District	Type of Monitor	Parameters
DC Station No. 02	Long term trending	Bunawan	Manual	PM_{10}, SO_2, NO_2, O_3
DC Station No. 07	Roadside	Poblacion	Manual	PM_{10}, SO_2, NO_2, O_3
DC Station No. 11	Long term trending	Talomo-Toril	Manual	PM_{10}, SO_2, NO_2, O_3
DC Station No. 14	Roadside	Talomo-Toril	Manual	PM_{10}, SO_2, NO_2, O_3
DC Station No. 15	General ambient	Buhangin	Automatic	PM_{10}, SO_2, NO_2, O_3, CO, BTX
DC Station No. 16	General ambient	Calinan	Automatic	PM_{10}, $PM_{2.5}$

BTX: benzene toluene xylene
Source: Air quality management, Home page of EMB Region XI, (http://r11.emb.gov.ph/programs/air-quality-management/)



Source: Air quality management, Home page of EMB Region XI

Figure 1.1 Location Map of DC AQMN

The results of air quality monitoring conducted by EMB XI in 2019 (1st Quarter and 2nd Quarter assessments) are shown below.

(1) PM_{10}

Table 1.2 below shows the results of air quality in terms of PM_{10} in µg/Ncm based on the 24-hour ambient air monitoring conducted by EMB XI during the 1st Quarter (Jan-March) and

2nd Quarter (Apr-Jun) in 2019.

Table 1.2 Result Summary of PM_{10} in Monitoring Stations (1st and 2nd Quarter in 2019)

Sampling Stations	Type of Monitor	Quarter in 2019	Concentration Min-Max, µg/NCM	Average µg/NCM	Guideline Value (GV), µg/NCM	Remarks	Air Quality Index
DC Station No. 02	Manual	1st	5.9-79.0	34.18	150	Within GV	Good & Fair
		2nd	10.40-101.60	33.64	150	Within GV	Good & Fair
DC Station No. 07	Manual	1st	5.5-72.8	39.77	150	Within GV	Good & Fair
		2nd	6.22-74.50	33.53	150	Within GV	Good & Fair
DC Station No. 11	Manual	1st	4.4-78.6	19.08	150	Within GV	Good & Fair
		2nd	6.22-44.30	23.42	150	Within GV	Good
DC Station No. 14	Manual	1st	13.3-76.1	43.44	150	Within GV	Good & Fair
		2nd	27.60-67.43	48.62	150	Within GV	Good & Fair
DC Station No. 15	Automatic	1st	23.36-64.36	39.21	150	Within GV	Good & Fair
DC Station No. 16	Automatic	2nd	15.75-75.28	34.20	150	Within GV	Good

Source: 1st and 2nd Quarter Assessment Report 2019, EMB XI

As shown in Table 1.2, each station during 1st and 2nd Quarter in 2019 shown maximum and average PM_{10} concentration in way below the guideline value of 150 µg/Nm^3.

(2) $PM_{2.5}$

Table 1.3 shows the results of air quality monitoring at DC Station No. 15 and No. 16 (Automatic Stations) in terms of $PM_{2.5}$ based on daily sampling.

Table 1.3 Result Summary of $PM_{2.5}$ in Automatic Stations (1st and 2nd Quarter in 2019)

Sampling Station	Type of Monitor	Quarter in 2019	Concentration Min-Max, µg/NCM.	Average µg/NCM	Guideline Value (GV) µg/NCM	Remarks	Air Quality Index
DC Station No. 15	Automatic	1st	7.92-25.59	13.08	50	Within GV	No AQI
DC Station No. 16	Automatic	2nd	11.25-47.97	28.05	50	Within GV	No AQI

Source: 1st and 2nd Quarter Assessment Report 2019, EMB XI

As shown in Table 1.3, each automatic station during 1st and 2nd Quarter in 2019 shown results of the monitoring for $PM_{2.5}$ that the concentrations are below the 24-hour guideline value.

(3) Sulfur Dioxide (SO_2)

Table 1.4 shows the results of air quality monitoring in terms of SO_2 in µg/Nm^3 based on the 24-hour ambient air monitoring conducted by EMB XI.

Table 1.4 Result Summary of SO_2 in Monitoring Stations (1st and 2nd Quarter in 2019)

Sampling Stations	Type of Monitor	Quarter in 2019	Concentration Min-Max, µg/NCM	Average µg/NCM	Guideline Value (GV), µg/NCM	Remarks	Air Quality Index
DC Station No. 02	Manual	1st	0.001-0.001	0.001	180	Within GV	Good
		2nd	0.001-5.93	1.51	180	Within GV	Good
DC Station No. 07	Manual	1st	0.001-0.001	0.001	180	Within GV	Good
		2nd	0.001-4.27	1.22	180	Within GV	Good
DC Station No. 11	Manual	1st	0.001-0.001	0.001	180	Within GV	Good
		2nd	0.001-5.4	1.94	180	Within GV	Good
DC Station No. 14	Manual	1st	0.001-3.710	0.413	180	Within GV	Good
		2nd	0.001-8.65	2.40	180	Within GV	Good
DC Station No. 15	Automatic	1st	1.92-5.77	3.78	180	Within GV	Good
		2nd	3.15-16.22	11.34	180	Within GV	Good

Source: 1st and 2nd Quarter Assessment Report 2019, EMB XI

As shown in Table 1.4, the results of monitoring for Sulfur Dioxide (SO_2) are way below the standard having an air quality index of "Good".

(4) Nitrogen Dioxide (NO_2)

Table 1.5 shows the results of air quality monitoring in terms of NO_2 in μg/Nm^3 based on the air monitoring conducted by EMB XI.

Table 1.5 Result Summary of NO_2 in Monitoring Stations (1st and 2nd Quarter in 2019)

Sampling Stations	Type of Monitor	Quarter in 2019	Concentration Min-Max, μg/NCM	Average μg/NCM	Guideline Value (GV), μg/NCM	Remarks	Air Quality Index
DC Station No. 02	Manual	1st	1.79-18.04	11.03	150	Within GV	No AQI
		2nd	3.94-15.67	8.86	150	Within GV	No AQI
DC Station No. 07	Manual	1st	6.25-25.04	15.27	150	Within GV	No AQI
		2nd	2.73-17.62	13.80	150	Within GV	No AQI
DC Station No. 11	Manual	1st	5.12-12.50	7.52	150	Within GV	No AQI
		2nd	16.33	10.78	150	Within GV	No AQI
DC Station No. 14	Manual	1st	9.67-22.47	15.57	150	Within GV	No AQI
		2nd	10.12-21.01	16.65	150	Within GV	No AQI
DC Station No. 15	Automatic	1st	6.78-22.86	13.86	150	Within GV	N/A
		2nd	1.17-16.59	9.18	150	Within GV	N/A

Source: 1st and 2nd Quarter Assessment Report 2019, EMB XI

As shown in Table 1.5, the results of monitoring for NO_2 are way below the guideline value of 150 μg/NCM.

(5) Ozone (O_3)

Table 1.6 shows the results of air quality monitoring at the four (4) manual stations in terms of O_3 in μg/Nm^3 based on the 8-hour ambient air monitoring conducted by EMB XI.

Table 1.6 Result Summary of NO_2 in Monitoring Stations (1st and 2nd Quarter in 2019)

Sampling Stations	Type of Monitor	Quarter in 2019	Concentration Min-Max, μg/NCM	Average μg/NCM	Guideline Value (GV), μg/NCM	Remarks	Air Quality Index
DC Station No. 02	Manual	1st	0.001-19.45	4.04	60	Within GV	Good
		2nd	0.001-5.65	1.32	60	Within GV	Good
DC Station No. 07	Manual	1st	0.001-15.17	3.26	60	Within GV	Good
		2nd	0.001-14.43	2.21	60	Within GV	Good
DC Station No. 11	Manual	1st	0.001-6.98	2.70	60	Within GV	Good
		2nd	0.001-4.14	1.27	60	Within GV	Good
DC Station No. 14	Manual	1st	0.001-32.24	5.80	60	Within GV	Good
		2nd	0.001-26.1	3.21	60	Within GV	Good

Source: 1st and 2nd Quarter Assessment Report 2019, EMB XI

Result of the sampling for Ozone (O_3) shows that the concentrations are below the standard. The Air Quality Index (AQI) for O_3 is "Good" for each monitoring station.

(6) Carbon Monoxide (CO)

Table 1.7 shows the results of air quality monitoring in terms of Carbon Monoxide (CO) based on the continuous ambient air sampling in Davao City International Airport.

Table 1.7 Result Summary of NO_2 in Monitoring Stations (1st and 2nd Quarter in 2019)

Sampling Stations	Type of Monitor	Quarter in 2019	Concentration Min-Max, ppm	Average ppm	Guideline Value (GV), ppm	Remarks	Air Quality Index
DC Station No. 02	Manual	1st	1.15-1.72	-	9	Within GV	Good
		2nd	1.33-1.89	1.55	9	Within GV	Good

Source: 1st and 2nd Quarter Assessment Report 2019, EMB XI

Result of the continuous monitoring shows that Carbon Monoxide (CO) concentration obtained

from the automatic station are way below the standard. The equivalent Air Quality Index (AQI) for CO concentration is "Good".

1.2 Water Quality

Water quality monitoring for the freshwater and marine waters are carried out in accordance with the Water Quality Guidelines (WQG) stipulated in Tables 3 to 6, Section 6.1 of DAO 2016-08.

(1) River Water

In Davao, two of the rivers have been designated as Water Quality Management Areas namely, Davao River and Talomo River. Table 1.8 shows water quality of Davao River and Table 1.9 shows water quality of six rivers in Davao City.

Table 1.8 Water Quality Downstream of Davao River

Parameter	Minimum	Maximum	Average	Water Quality Criteria for Class B
Temperature (°C)26-30	27.0	32.0	28.8	26-30
pH	7.6	8.9	8.3	6.5-8.5
DQ (mg/L)	3.4	9.4	6.9	5.0 (minimum)
BOD (mg/L)	0.2	5.5	1.3	5
TSS (mg/L)	3	940	141	65
Fecal Coliform (MPN/100 ml)	2,000	5,400,000	107,562(Geomean)	100
Nitrates-N (mg/L)	0.89	29.23	11.83	7
Phosphates-P (mg/L)	0.11	2.03	0.80	0.5
Lead (mg/L)	<0.01	0.15	0.02	0.01
Cadmium (mg/L)	<0.003	0.006	0.003	0.003
Copper as Dissolved Copper (mg/L)	<0.001	0.04	0.01	0.02
Zinc (mg/L)	<0.001	0.06	0.03	2

Source: Water Quality Assessment Report (CY 2016) EMB XI

Table 1.9 Table 1.8 Water Quality Six Rivers in Davao

River	Classification	Value	Parameter		
			DO (mg/l)	BOD(mg/l)	TSS(mg/l)
Davao (Downstream)	B	Ave	6.9	1.3	**141**
		Max	**3.4**	**5.5**	**940**
Davao (Upstream)	A	Ave	7.9	0.7	**152**
		Max	6.8	**3.1**	**2465**
Talomo	B	Ave	7.2	1.4	35
		Max	**3.2**	**11.5**	**640**
Lipadas	C	Ave	6.6	2.4	13
		Max	**0**	**10**	71
Matina	C	Ave	**3.7**	5.4	13.4
		Max	**0.9**	**13**	30
Bunawan	C	Ave	6.6	1.1	**108**
		Max	**4.7**	4.1	**752**
Lasang	B	Ave	7.5	1.4	49
		Max	**4.8**	**21.0**	**255**
Water Quality Criteria	A		5(minimum)	3(maximum)	50
	B		5(minimum)	5(maximum)	65
	C		5(minimum)	7(maximum)	80

Note: For DO, minimum value is shown in Max column. Bold figure is beyond the Water Quality Criteria.

Source; Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

(2) Recreational Beach Water Quality

Region XI has three (3) main areas where recreational waters or beaches are being monitored by EMB Region XI. In Davao City there are 11 recreational waters (beaches) each of which has one water quality monitoring station. Table 1.10 shows the water qualities of 10 recitational beaches among the 11 beaches.

Table 1.10 Recreational Beach Water Quality (4th Quarter in 2018)

Parameter	Stn. No.	Sta. ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave	Min	Max	Water Quality Guideline
DO, mg/L	1	Kalayaan Beach Resort	6.3	6.4	6.4	6.2	5.9	6.5	5.4	8.1	7.4	6.8	-	5.9	6.5	5.4	8.1	6 (minimum)
	2	Resort	6	6.3	6.3	6.6	5.8	6.5	6	7.4	8.1	7.1	-	6.2	6.6	5.8	8.1	
	3	Seagull Beach Resort	6.6	6.2	6.2	6.2	6.2	7	5.9	8.5	10	7	-	6.9	7.0	5.9	10.0	
	4	Bonguyan Beach Resort	6.2	6.2	6.2	6.4	6.0	8.3	5.9	5.7	7.4	5.7	-	5.6	6.3	5.6	8.3	
	5	Liberty Beach Resort	5.2	5.8	5.8	9.6	3.9	5.3	5.7	7.3	7.5	5.1	-	7	6.2	3.9	9.6	
	6	Marina Azul I	9.8	5.8	5.8	9.2	6.2	7.2	5.9	5.3	7	6.8	-	6.1	6.8	5.3	9.8	
	7	Coaco Beach Resort	-	6.0	6	6.1	6.5	6.3	5.2	6	6.6	8.8	-	6.8	6.4	5.2	8.8	
	7a	Dagat Fiesta Beach Resort	-	6.2	6.2	5.7	6.5	6.4	5.4	5.8	7.1	7.3	-	7.6	6.4	5.4	7.6	
	14	Bago Beach Reosrt	6.6	6.4	6.4	6.7	5.9	6.2	6	6	8.4	6.8	-	5.8	6.5	5.8	8.4	
	16	Resort	6.9	6.3	6.3	6.8	7.6	6.4	5.8	7.3	9.5	7.1	-	7.4	7.0	5.8	9.5	
pH	1	Kalayaan Beach Resort	7.5	7.8	7.8	4.6	7.2	8.1	8.1	8.2	8.1	8.3	-	8.1	7.6	4.6	8.3	7.0-8.5
	2	Resort	7.6	7.2	7.2	6.9	5.5	8.2	8.2	8.2	8.1	8.5	-	8.2	7.6	5.5	8.5	
	3	Seagull Beach Resort	7.9	7.4	7.4	6.5	6.8	7.1	8.1	8.3	8.1	8.4	-	8.0	7.6	6.5	8.4	
	4	Bonguyan Beach Resort	7.7	7.5	7.5	6.4	6.3	8.1	8.2	8.2	8.1	8.5	-	8.2	7.7	6.3	8.5	
	5	Liberty Beach Resort	7.9	7.7	7.7	8.4	6.8	7.6	8.1	8.3	8.2	8.2	-	8.2	7.9	6.8	8.4	
	6	Marina Azul I	7.9	7.5	7.5	6.7	6.4	8.1	8.2	8.3	8	8.6	-	8.3	7.8	6.4	8.6	
	7	Coaco Beach Resort	8.3	7.7	7.7	5.9	6.9	8.1	8.3	8.2	8.2	8.5	-	8.3	7.8	5.9	8.5	
	7a	Dagat Fiesta Beach Resort	8.3	7.6	7.6	8.1	6.6	7.3	8.4	7.9	8.2	8.5	-	8.2	7.9	6.6	8.5	
	14	Bago Beach Reosrt	7.5	7.9	7.9	6.7	6.8	7.9	8.2	8.2	8.1	8.5	-	8	7.8	6.7	8.5	
	16	Resort	7.9	7.7	7.7	7.8	7.9	8.1	8.2	8.2	8.2	8.5	-	8.3	8.0	7.7	8.5	
Temp., °C	1	Kalayaan Beach Resort	30	28	28	30	31	31	29	29	29	30	-	29	29	28	31	26-30
	2	Resort	31	28	28	30	33	31	30	29	29	30	-	31	30	28	33	
	3	Seagull Beach Resort	30	27	27	31	31	31	31	29	29	30	-	29	30	27	31	
	4	Bonguyan Beach Resort	31	28	28	31	30	32	30	31	32	31	-	30	30	28	32	
	5	Liberty Beach Resort	30	28	28	32	32	32	30	30	30	31	-	31	30	28	32	
	6	Marina Azul I	30	28	28	31	33	32	31	30	32	31	-	34	31	28	34	
	7	Coaco Beach Resort	-	28	28	29	30	29	30	29	30	29	-	30	29	28	30	
	7a	Dagat Fiesta Beach Resort	-	28	28	29	29	29	30	31	30	29	-	32	30	28	32	
	14	Bago Beach Reosrt	30	28	28	31	32	31	30	30	30	30	-	29	30	28	32	
	16	Resort	29	28	28	29	31	29	31	29	30	29	-	31	29	28	31	
Fecal Coliform, MPN/100mL	1	Kalayaan Beach Resort	<180	260	260	350	-	330	220	27	240	130	-	1600	237	27	1600	100
	2	Resort	<180	<18	<18	4	-	<180	7.8	2	130	33	-	33	14	2	130	
	3	Seagull Beach Resort	<180	18	18	350	-	130	7.8	<1.8	110	4	-	2	24	2	350	
	4	Bonguyan Beach Resort	<180	230	230	23	-	<180	79	49	240	170	-	23	90	23	240	
	5	Liberty Beach Resort	28000	3500	350000	2300	-	160,000	49000	<180		>16000	-	92000	34391	2300	350000	
	6	Marina Azul I	180	140	140	110	-	1,100	920	31	3500	220	-	540	295	31	3500	
	7	Coaco Beach Resort	33	330	330	110	-	45	540	11	23	17	-	920	91	11	920	
	7a	Dagat Fiesta Beach Resort	23	78	78	17	-	20	22	350	79	33	-	6.8	38	7	350	
	14	Bago Beach Reosrt	<180	20	20	22	-	170	79	23	350	130	-	280	69	20	350	
	16	Resort	<1.8	<18	<18	110	-	<18	170	280	49	49	-	33	86	33	280	
Oil & Grease, mg/L	1	Kalayaan Beach Resort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	2	Resort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	3	Seagull Beach Resort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	4	Bonguyan Beach Resort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	5	Liberty Beach Resort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	6	Marina Azul I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	7	Coaco Beach Resort	-	<1	-	<1	-	-	-	<1	-	<1	-	-	<1	<1	<1	
	7a	Dagat Fiesta Beach Resort	-	<1	-	<1	-	-	-	<1	-	<1	-	-	<1	<1	<1	
	14	Bago Beach Reosrt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	16	Resort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Source: EMB XI

1.3 Waste

Domestic solid waste is managed by CENRO of Davao City. Namely solid waste generated in the Davao City is collected by the CENRO of the City of Davao and disposed of at the Carmen sanitary landfill site located in the mountainous area of the Davao city.

Table 1.11 shows data on domestic solid waste in Davao City.

Table 1.11 Domestic Solid Waste in Davao City (2017)

Population (thousand)	Waste Amount (ton/day)	Collected and landfilled (ton/day)	Landfill Site in Davao City
1,450	960	450	Carmen Sanitary Landfill

Source: Interview with CENRO, JICA Survey 2017

1.4 Soil

Davao City has an area of 244,000 hectares, or 8 per cent of the land area of Southern Mindanao Region or Region XI.

The quality of the soil in Davao city differ depending on the location in terms of color, texture, depth, drainage, relief, permeability, and fertility. All of these factors are attributive to the productivity of the soil, the ease in cultivation and adaptability to agriculture.

On the basis of the soil characteristics of Davao City, these are classified into seven series and one miscellaneous land type. These different soil series have been categorized into three groups depending on the topographic position they occupy in the landscape.

As summarized in Table 1.12, the three soil groups are the following;

- ✓ Soils of the plains and valleys;
- ✓ Soils in the intermediate uplands;
- ✓ Soils of hills and mountains

(Source; Comprehensive Land Use Plan, (2013-2022), Volume 1, City Government of Davao)

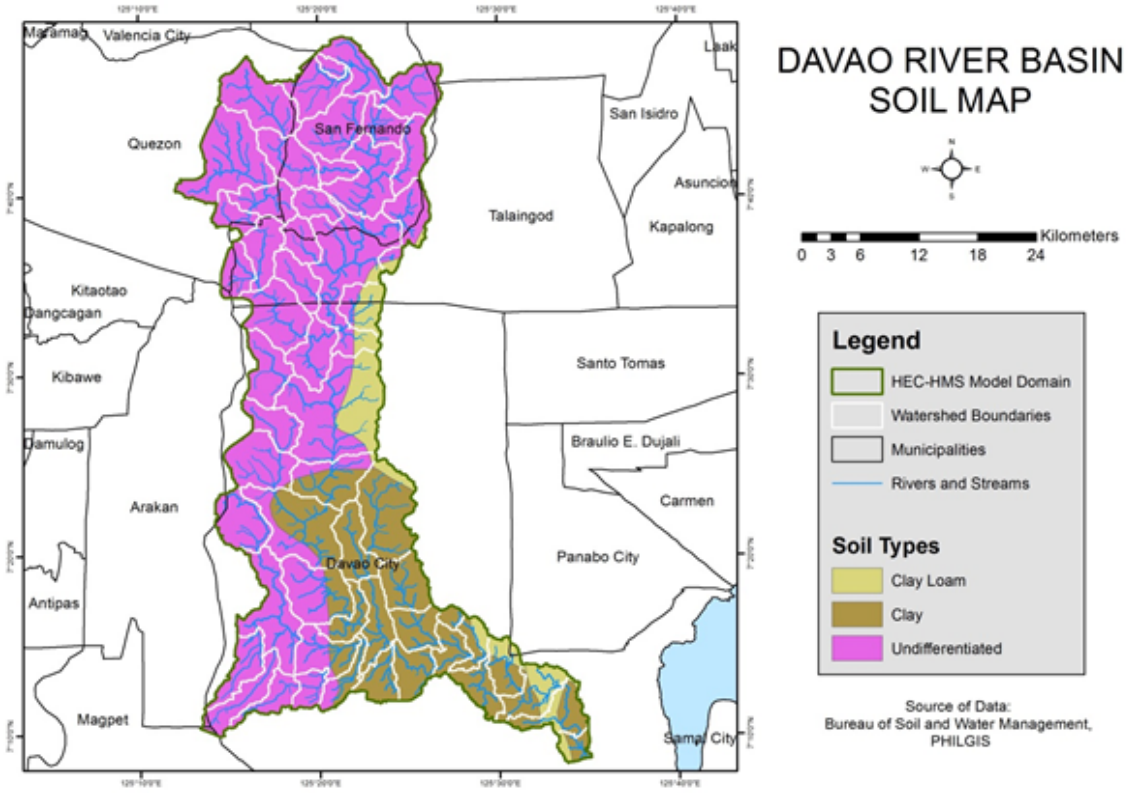
Table 1.12 Soil Groups by Topographic Position, Davao City

Topography/Soil Type	Source of Parent Material	Dominant Relief	Area (Has)
A. Plains and Valley San Miguel Silty Clay Loam	Alluvium of igneous	Nearly level to level	2,882.50
Matina Clay Loam	Alluvium form limestones, shale and sandstones	Flat to gently undulating	6,649.75
B. Intermediate upland			
Tugbok Clay	Igneous Rock Andesites	Undulating to gently	78,545.85
Faraon Clay	Soft Corraline Limestone	Undulating to gently rolling	5,151.17
Cabantian Clay	Soft Shales with mixtures of weathered gravels and pebbles	Undulating to hilly	19,072.62
C. Hills & Mountains Camansa Sandy Clay Loam	Shales& sandstones with weathered gravel and sand Different kinds of	Hilly, Mountains	49,859.43
Mountain Soils, undifferentiated	igneous and metamorphic rocks	These solids are generally shallow and stony with excessive drainage:	80,316.62
Cabangan Clay Loam		inaccessible and not suited to agriculture	1,522.06
TOTAL			244,000.00

Original Source: BSWM-XI

Source: Comprehensive Land Use Plan, (2013-2022), Volume 1, City Government of Davao

Figure 1.2 shows a map of Soil in Davao River Basin.



Source: Region 11 Davao River Badin; DREM Flood Forecasting and Flood Hazard Mapping University of the Philippines and the Department of Science and Technology 2015

Figure 1.2 Davao River Basin Soli Map

1.5 Noise

Ambient noise monitoring surveys in Davao City were conducted for the study for Environmental Impact Statement (EIS) for the Davao City Bypass Construction Project in 2014, as shown below (Source; EIS for the Davao City Bypass Construction Project, August 2014, ECOSYSCORP, INC.)

- ✓ Sampling results of the 10-minute average noise level daytime monitoring along sampling Sta. N1 to N5 showed that existing noise levels exceeded the permissible DENR limit of 55 dBA for Class "AA" (a section or contiguous area which requires quietness, such as an area within 100 m from school sites, nursery schools, hospitals, places of worships, and special homes for the aged) and 65 dBA for Class "B" (a section or contiguous area which is primarily commercial area) areas.
- ✓ The observed daytime noise level at Sta. N2 (72 dBA) and Sta. N3 (74 dBA) which are both categorized as AA areas, exceeded the DENR standard of 55 dBA. Sound generated by the passing vehicles are the identified sources of noise at the time of sampling. It is important to note that these two (2) sampling stations were established approximately 10 m from Catholic chapels.

- ✓ For the "B" categorized areas (Sta. N1, N4, and N5), the observed noise level ranged from 72-80 dBA. The values recorded exceeded the DENR limit of 65 dBA for daytime noise level standard. A relatively high noise level of 80 dBA was observed at Sta. N4, which is located in front of the University of Southeastern Philippines (USeP) Mintal Campus along the Davao-Bukidnon National Highway. The high noise recorded can be attributed to the volume of vehicles passing along the highway and the perennial blowing of horns.
- ✓ Table 1.13 presents the complete results of the noise level monitoring conducted along the proposed bypass alignment.

Table 1.13 Ambient Noise Level along the Proposed Davao City Bypass Alignment

Station No.	Date & Time	Average Noise Level (dBA)	DENR Standard	Remarks
N1	31 March 2014 1605-1615H	72	65**	Noise coming from passing vehicles; with light wind; prevailing wind is NE;
N2	31 March 2014 1755-1805H	72	55*	Noise coming from passing vehicles; with light wind; prevailing wind is NE;
N3	01 April 2014 1005-1015H	74	55*	Noise coming from passing heavy equipment; with light wind; prevailing wind is SE
N4	01 April 2014 1330-1340H	80	65**	Noise coming from blowing of horns and passing heavy trucks; with light wind; prevailing wind is SE
N5	01 April 2014 1705-1715H	73	65**	No unusual noise at the station; with light wind; prevailing wind is NE
Class AA* a section or contiguous area which requires quietness, such as an area within 100 m from school sites, nursery schools, hospitals, places of worships, and special homes for the aged Class B** a section or contiguous area which is primarily commercial area				

Source; EIS for the Davao City Bypass Construction Project, August 2014, ECOSYSCORP, INC.

2. Natural Conditions

2.1 Climate

Located in the south of Mindanao Island, Davao City is located on the boundary between the tropical and the equatorial climate zones. Table 2.1 shows past metrological data of Davao City.

Table 2.1 Meteorological Data of Davao City

Year Month in 2004	Total Rainfall (in mm)	Number of Rainy Days	Dew Point (℃)	Relative Humidity (%)	Temperature (℃)		
					Max	Min	Mean
1999	**2,242.9**	**208**	**24.0**	**82.0**	**35.5**	**21.8**	**28.1**
2000	**2,357.5**	**208**	**24.1**	**82.0**	**34.2**	**22.2**	**27.2**
2001	**1,447.9**	**172**	**24.2**	**81.0**	**34.7**	**21.3**	**28.0**
2002	**1,637.3**	**159**	**23.9**	**79.5**	**35.0**	**21.9**	**28.4**
2003	**1,759.3**	**178**	**24.2**	**81.5**	**35.2**	**21.0**	**28.1**
2004	**1,941.8**	**162**	**24.1**	**79.3**	**35.9**	**21.7**	**28.6**
January	100.1	18	23.5	78.0	35.9	22.6	28.3
February	169.2	15	23.4	80.0	34.0	21.7	27.8
March	172.7	9	24.0	79.0	33.9	22.8	28.3
April	171.5	10	24.3	75.0	34.4	23.2	29.6
May	224.2	17	24.8	82.0	35.9	23.2	28.6
June	94.2	13	24.2	78.0	34.1	23.4	29.2
July	184.0	16	24.2	82.0	35.0	22.8	28.6
August	16.2	4	24.3	78.0	34.5	23.1	28.4
September	280.9	18	24.2	82.0	33.3	22.8	28.0

Year Month in 2004	Total Rainfall (in mm)	Number of Rainy Days	Dew Point (°C)	Relative Humidity (%)	Temperature (°C)		
					Max	Min	Mean
October	181.5	12	24.1	78.0	34.4	23.8	29.1
November	89.0	10	24.3	78.0	34.5	22.1	28.3
December	258.3	20	24.4	81.0	34.6	23.5	29.0

Source: Philippine Atmospheric Geo- physical and Astronomical Services Administration, Davao City

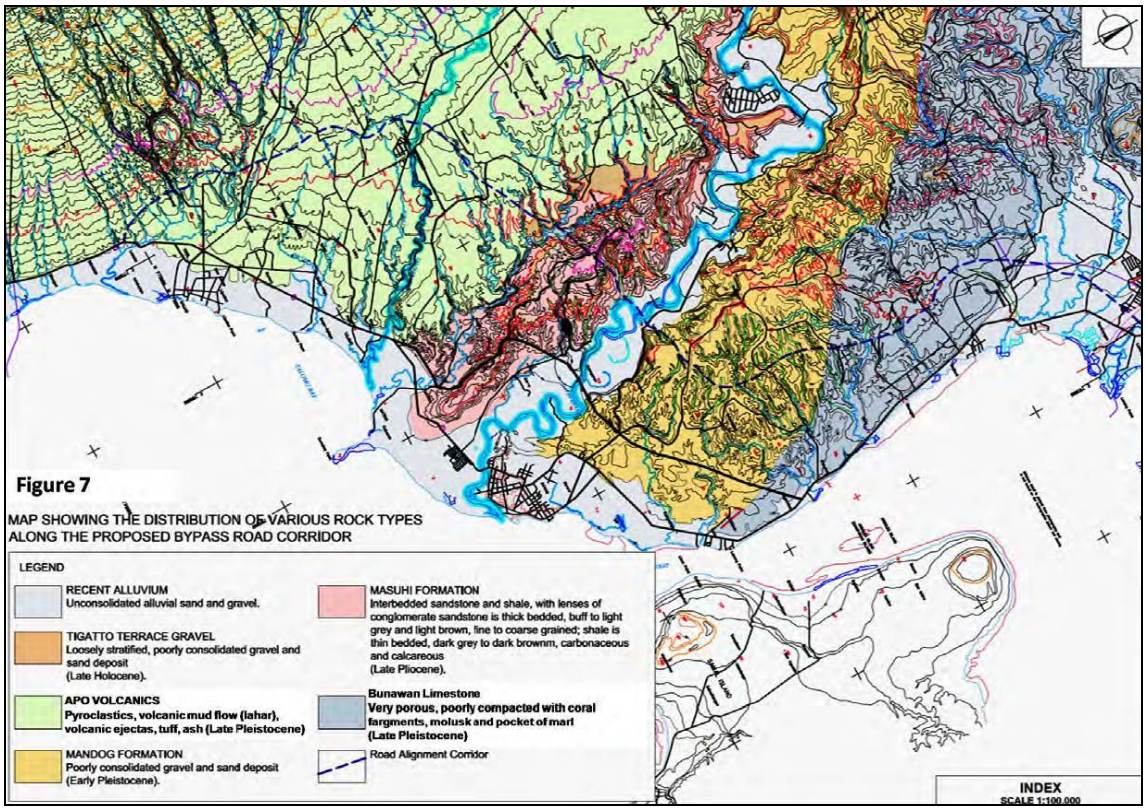
2.2 Geology

Based on the mapping of the Mines and Geosciences Bureau Region XI, the Geology of Davao City can be summarized in Table 2.2. In addition, Figure 2.1 shows Geology of Davao City.

Table 2.2 Stratigraphic Sequence of Subsoil and Rocky Type around Davao City

Formation		Description	Geologic Age
Alluvium		Loose, unconsolidated gravel, sand and clay deposits	Holocene (Recent)
Tigatto Terrace Gravel		Loosely stratified gravel and sand deposits	Holocene
Bunawan Limestone		Coralline limestone	Late Pleistocene
Apo Volcanic Complex	Apo Volcanics	Intercalated pyroclastics and volcaniclastics with lenses of volcanic ash	Pleistocene
	Talomo Volcanics	Volcanic flows with intercalated pyroclastics, tuff and volcaniclastics	Pleistocene
	Apo-Talomo Volcanic Cones	Andesitic-dacitic volcanic lava	Pleistocene
Mandog Formation		Interbedded consolidated sand and clay with minor gravels	Early to Late Pleistocene
Masuhi Formation		Interbedded sandstone and shale with lenses of conglomerate	Late Miocene to Early Pliocene

Original Source: Modified from "Mines and Geo-Sciences Bureau"
Source: Preparatory Survey for Southern Mindanao Economic Corridor Improvement (Davao City Bypass Construction) Project, Draft Final Report, October 2014, JICA



Original Source of Map: Original Source: Mines and Geosciences Bureau Region XI

Source; Preparatory Survey for Southern Mindanao Economic Corridor Improvement (Davao City Bypass Construction) Project, Draft Final Report, October 2014, JICA

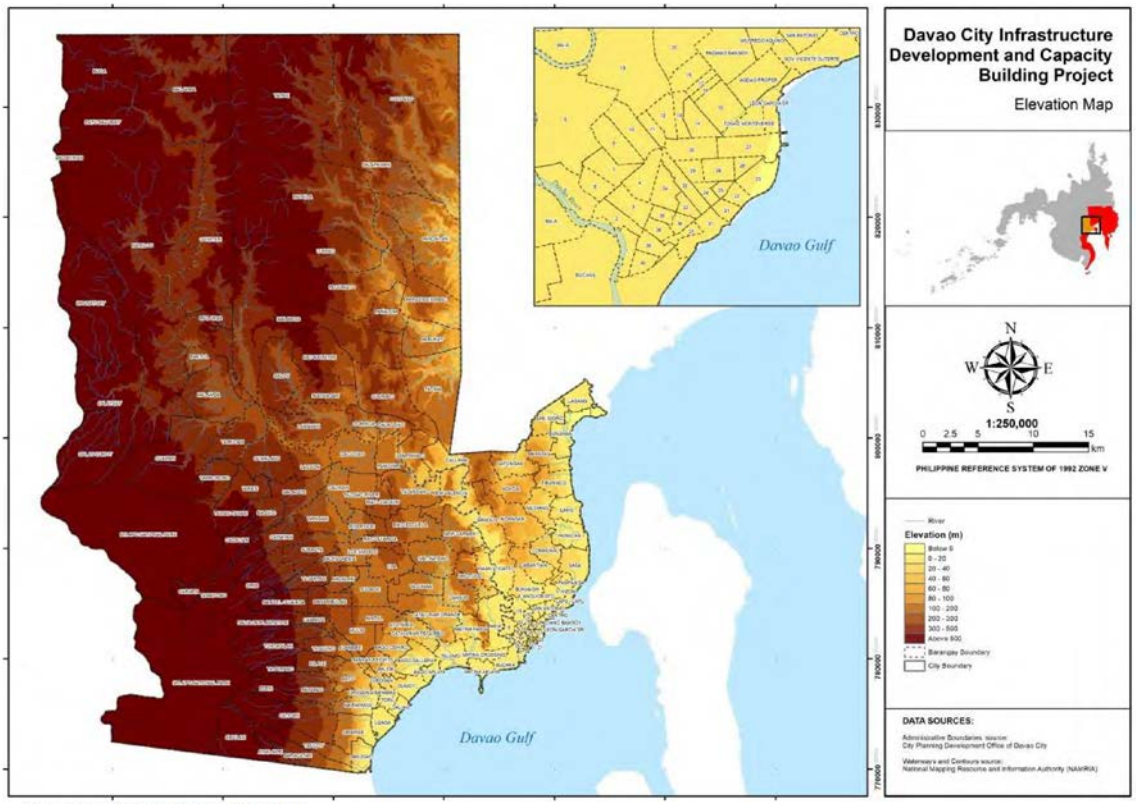
Figure 2.1 Geological Map of Davao City

2.3 Topographical Aspect

The Davao Region is characterized by extensive mountain ranges extending along the western border, in the northern central area and in the northwestern area leading to the peninsula in the southeast with uneven distribution of plateaus and lowlands. Its coastline reached to 1,600 km^2. The area is dominated by peninsular and island topography.

According to IM4D, the configurations of Davao City are summarized below.

- ✓ Given the land forms comprising Davao City, the elevation ranges from below 0 meter to as high as 1,385 meters.
- ✓ Areas with high elevation are found mostly in Congressional District 3 and some in District 2.
- ✓ Low-elevation areas are distributed along the coastline barangays of District 1 and District 2, as shown in Figure 2.2.



Source; Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

Figure 2.2 Elevation Map of Davao City

In addition, according to the JICA Preparatory Survey for Southern Mindanao Economic Corridor Improvement (Davao City Bypass Construction) Project (Draft Final Report, October 2014, JICA), the topographical aspect in Davao City is summarized as follows. In the explanation below the project site stands for the bypass construction which covers the sewerage project in this survey.

- ✓ The general landscape of the project site is marked by complex morphologies which are controlled by the geological structures. Most of the geological structures are associated either by faults and/or stratigraphic lines. The relief varies from rolling hills to rugged mountains with elevations between 10m and 220m.
- ✓ The topography manifests high dissection particularly towards the mountainous and rugged relief where passages of faults and various geologic lineaments are strongly manifested.
- ✓ The mountainous and high relief areas appear generally elongated towards the north - northwest. This elongation runs roughly co-linear with the direction of anticlines and synclines of Quaternary-Tertiary sedimentary rocks.
- ✓ Most of the drainage-lines in and around the project site are structurally-controlled. They flow generally from west - northwest towards east - southeast. All empty their loads towards Davao Gulf in the east.

2.4 Protected Areas

Table 2.3 shows a list of protected areas in the Davao Region.

Table2.3 Projected Area in Davao Region

Name/Location		Province	Area (has.)	Proclamation/Republic Act	
				No.	Date
Initial Component					
1.	Baganga Bay Protected Landscape/ Seascape Municipality of Baganga, Davao Oriental - Brgys. Bobonao, Central, Dapnan, Kembangan, Lambajon, Salingcomot, San Victor, Lucod, Saoquegue & Ban-ao	Davao Oriental	20,500.00	Proc. 2152	Dec. 29, 1981
2.	Baganga Protected Landscape Municipality of Baganga - Brgy. Central Brgy. Central, Davao Oriental	Davao Oriental	114.00	Proc. 195	Dec. 8, 1987
3.	Mati Protected Landscape Mati, Davao Oriental Municipality of Mati, Davao Oriental Brgys. Culian, Sainz & Sudlon	Davao Oriental	1,017.00 1,050.00	Proc. 222 Proc. 912	Feb. 2, 1967 Sept. 6, 2005
4.	Mabini Protected Landscape/Seascape Municipality of Mabini, ComVal Brgys. Cadunan, Ccccuambog, Del Pilar, Pindasan, San Antonio & Tagnanan	Compostela Valley	6,106.00 6,106.00	Proc. 2151 Proc. 316	Dec. 29, 1957 May. 31, 2000
5.	Mainit Hot Springs Protected Landscape Nabunturan, Compostela Valley, Municipality of Nabunturan, ComVal, Brgys. Mainit & Bukal	Compostela Valley	1,381.00 1,775.00	Proc. 446 Proc. 320	Dec. 12, 1957 May. 31, 2000
6.	Samal Island Protected Landscape/Seascape Babak District, Island Garden City of Samal Brgys. Kinawitnon, Caliclic, Villarica, Miranda, Tambo, Camudmud, Balet, San Isidro, Libuak & Tagpopongan	Davao del Norte	7,050.00	Proc. 2152	Dec. 29, 1981
7.	Mt. Apo Natural Park	Davao del Sur/	76,900.00	Proc. 59	May 9, 1936

Name/Location		Province	Area (has.)	Proclamation/Republic Act	
				No.	Date
	Municipality of Bansalan, Davao del Sur - Brgys. Alegre, Altavista, Darapuay, Eman, Linawan, Bitaug, Anonang, Sibayan, Managa & Tinongtongan Municipality of Sta. Cruz, Davao del Sur Brgys. Sibulan, Tibolo, Melilia, Saliducon, Sinoron, Zone II, Coronon, Jose Rizal & Astorga City of Digos, Davao del Sur Brgys. Goma, Binaton, Balabag & Kapatagan City of Davao, Davao del Sur Calinan District - Brgys. Tamayong & Manuel Guianga Toril District - Brgys. Sibulan, Tungkalan, Tagurano, Eden, Baracatan & Daliaon Municipality of Magpet, North Cotabato Brgys. Kinarum, Bongolanon & Tico Muncipality of Makilala, North Cotabato Brgys. New Israel, Old Bulatukan, Biangan, Buhay, Batasan & Buenavida City of Kidapawan, North cotabato - Brgys. Perez, Balabag & Ilomavis	Davao City	72,113.00 64,053.00	Proc. 882 R.A. 9237	Sept. 26, 1996 Feb. 3, 2004
8.	Malagos Protected Landscape City of Davao, Davao del Sur Baguio District - Brgy. Malagos	Davao City	235.00	Proc. 613	Aug. 31, 1933
SUB-TOTAL			100,883.00		
Additional Component (Established)					
9.	Pujada Bay Protected Landscape/Seascape Municipality of Mati, Davao Oriental - Brgys. Lawigan, Tamisan, Bobon, Dahican, Dawan, Mamali, Macambol, Central, Matiao & Badas	Davao Oriental	21,200.00	Proc. 451	July 31, 1994
10.	Mt. Hamiguitan Range Wildlife Sanctuary Municipality of Mati, Davao Oriental - Brgy. Macambol Municipality of Gov. Generoso, Davao Or. Brgy. Sergio Osmeña Municipality of San Isidro, Davao Oriental Brgy. La Union	Davao Oriental	6,843.00	R.A. 9303	July 30, 2004
11.	Aliwagwag Protected Landscape Municipality of Compostela, ComVal Brgy. Ngan Municipality of Cateel, Davao Oriental Brgy. Aliwagwag Municipality of Boston, Davao Oriental Brgy. Caatihan	Davao Oriental	10,590.00	Proc. 139	April 5, 2011
SUB-TOTAL			38,633.00		
Additional Component (For Establishment)					
12.	San Isidro Protected Seascape Municipality of San Isidro, Davao Oriental Brgys. Wason, Batobato, Baon, Bitaugan, Cambaleon, Talisay & La Union	Davao Oriental	17,590.00		
13.	Mt. Tagub-Kamplili Protected Landscape Municipality of New Bataan, ComVal Brgy. Andap Municipality of Maragusan, ComVal - Brgys. Nawasa, Langgawisan, Bahi, Mapawa, Coronobe, New Albay, Talian, Tandik, Lahi, Tupas, Paloc, New Manay, Parasanon, Mahayahay, Mabugnao, Bagong Silang, Tigbao & New Panay	Compostela Valley	42,953.00		
SUB-TOTAL			60,543.00		
TOTAL			**200,059.00**		

Source: Home page of DENR/Region 11 – Davao
http://r11.denr.gov.ph/index.php/e-library/manual-of-land-disposition/100-statistical-data/339-list-of-protected-areas

2.5 Flora and Fauna

The Philippines is one of the world's 18 mega-diversity countries, which collectively host more than 70% of the world's species. It exhibits very high species endemism at it is home to at least 25 genera of plant and 49% of terrestrial fauna; it hosts more than 52,177 described species of which more than half is found nowhere else in the world. On a per unit area basis, the

Philippines probably harbors more diversity of life than any other country on the planet. However, it is also the "hottest of the hotspots" in terms of biological diversity because of the rapid rate of habitat destruction, ineffective implementation and weak enforcement of existing laws. (Source; Inside Filipino Eden, Highlighting Philippines' Major Environmental Laws and Biodiversity, https://www.insidefilipinoeden.com/)

(1) Biodiversity in Davao

According to IM4D, flora and fauna of the Biodiversity Sites in Davao City as of 2011 are summarized in Table 2.4.

Table 2.4 Flora and Fauna of the Biodiversity Sites in Davao City

Location	Flora	Fauna	Forest Cover (Estimated)
Paquibato District	Heritage trees, wild orchids	Tarsiers, wild boar, Philippine brown deer, Philippine eagles	15 hectares of natural and residual forests
Marilog District	Heritage trees, Walin-waling orchids	Wild boars, Philippine brown deer	24 hectares of natural and residual forests
Barangay Malagos, Baguio District	Heritage trees	Philippine bats, Philippine eagles	
Toril District	Heritage trees, wild orchids	Marine turtles (hawksbills, green turtles, Olive Ridleys, leatherbacks) and nesting grounds	
Baguio District	Heritage trees	Wild boars, Philippine brown deer	18 hectares of natural and residual forests
Barangay Matina Aplaya, Talomo District	Mangrove forest	Marine turtle (hawksbill, green turtle, Olive Ridley, leatherback) and nesting ground	2 hectares of mangrove forests
Barangay Lasang, Bunawan District	Mangrove forest	Whale sharks, dugong	6 hectares of mangrove forests
Mt. Talomo	Almasiga trees	Wild boars, Philippine eagles, hornbills, deer, bats	

Original Source: Comprehensible Land Use Plan (2013-2022)
Source: Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

In addition, Table 2.5 shows endangered species found in Region XI.

Table 2.5 Endangered Fauna Species in Region XI

Common Name	Scientific Name	Description	Status
Hombron's kingfisher or the blue-capped kingfisher	Actenoides hombroni	Hombron's kingfisher or the blue-capped kingfisher is a species of bird in the family Alcedinidae endemic to the Philippines. Its natural habitats are subtropical or tropical, moist, lowland forests and subtropical or tropical, moist, montane forests. It is threatened by habitat loss	Vulnerable
N/A	Ansonia muelleri	Ansonia muelleri is a species of toad in the family Bufonidae. It is endemic to the Philippines. Its natural habitats are subtropical or tropical dry forests, subtropical or tropical moist lowland forests, subtropical or tropical moist montane forests, rivers, intermittent rivers, and freshwater springs. It is threatened by habitat loss.	Vulnerable
N/A	Ansonia mcgregori	Ansonia mcgregori is a species of toad in the family Bufonidae. It is endemic to the Philippines. Its natural habitats are subtropical or tropical dry forests, subtropical or tropical moist lowland forests, subtropical or tropical moist montane forests, rivers, intermittent rivers, and freshwater springs. It is threatened by habitat loss.	Vulnerable
N/A	Camiguin forest rat	Found only on one tiny island in the Philippines, the Camiguin forest rat is a little-known species as it has only been known to scientists since 2002. The Camiguin forest rat has soft, thick dark reddish-brown fur, which is slightly paler on the underside. The snout and the sides of the face are covered in dark grey hairs. The Camiguin forest rat has small, nearly naked ears, relatively large forefeet, and long, wide hindfeet. The relatively short tail, which measures less than the head and body length, is almost entirely hairless.	Vulnerable
Philippine leafbird	Chloropsis flavipennis	The Philippine leafbird (Chloropsis flavipennis) is a species of bird in the Chloropseidae family. It is endemic to the Philippines. It is found in the islands of Mindanao, Leyte, and Cebu. Its natural habitat is subtropical or tropical moist lowland forests. It is threatened by habitat loss. Its	Vulnerable

Common Name	Scientific Name	Description	Status
		stronghold appears to be Mindanao, with populations small in Leyte and in Cebu, the species could already be extinct.	
N/A	Coeliccia exoleta	Coeliccia exoleta is a Philippine endemic species, confined to Mindanao and Camiguin islands. So far, the species has been recorded in 12 sites. The species has a very fragmented range and occurs in low numbers. It was recorded once in Camiguin, and there is reference in Muller's collection to several sites in Mindanao. Surveys of several of the Mindanao sites in recent years have failed to find the species.	Vulnerable
Mindanao Shrew Rat	Crunomys melanius	The Mindanao Shrew Rat is a species of rodent in the family Muridae. It is found only in the Philippines.	Vulnerable
Philippine flying lemur or Philippine colugo	Cynocephalus volans	The Philippine flying lemur or Philippine colugo, known locally as the kagwang, is one of two species of flying lemurs, the only two living species in the order Dermoptera. Additionally, it is the only member of the genus Cynocephalus. The other species is the Sunda flying lemur. Recent research from genetic analysis suggests two other species, the Bornean flying lemur and the Javan flying lemur, may exist, as well, but they have yet to be officially classified so. Although called a flying lemur, it cannot fly and is not a lemur. Both species of Dermoptera are classified under the superorder Euarchonta which includes the Scandentia and the primates, as well as an extinct order of mammals, the Plesiadapiformes.	Vulnerable
Mindanao flying dragon	Draco mindanensis,	Mindanao flying dragon is a lizard species endemic to the Philippines. Characterized by a dull grayish brown body color and a vivid tangerine orange dewlap, this species is one of the largest of the genus Draco. It is diurnal, arboreal, and capable of gliding. The Mindanao flying dragon inhabits regions of primary and secondary-growth forests. There appears to be a dependence on primary dipterocarp forest for this species' survival. D. mindanensis is noted for being a bioindicator for the forested regions of Mindanao. Threatened heavily by deforestation, the IUCN has listed D. mindanensis as vulnerable. Currently, there are no specific conservation efforts being made to preserve the species. Rather, there are projects that target the protection of the habitats in which the Mindanao flying dragon lives.	Vulnerable
N/A	Drepanosticta centrosaurus	The species' habitat is subject to deforestation and pollution from human settlements. The known distributional range of Drepanosticta centrosaurus is in one of the few remaining forested areas in the Philippine archipelago although illegal logging and slash and burn farming are still ongoing. The continuing clearance of forest will eventually eliminate potential habitat for this species. The association of D. centrosaurus to freshwater supply makes contact with human settlement inevitable; the species is susceptible to disturbance, habitat clearance and domestic pollution. Presently, mining for various metals within the distributional range by small- to large-scale companies has led to rapid degradation of habitat as most of these mining firms employ open pit mining. Most of these mining activities do not follow sustainable mining practices, and this has led to contamination of waterways, which has also placed the larval stage under threat.	Vulnerable
Grey imperial pigeon	Ducula pickeringii	The grey imperial pigeon is a species of bird in the family Columbidae. It is found in Brunei, Indonesia, Malaysia, and the Philippines. Its natural habitats are subtropical or tropical moist lowland forests and plantations. It is threatened by habitat loss.	Vulnerable
Tagibo Water Frog	Podogymnura aureospinula	The Dinagat gymnure (Podogymnura aureospinula) is a species of mammal in the family Erinaceidae. It is endemic to the Philippines. Its natural habitat is subtropical or tropical dry forests. It is threatened by habitat loss.	Vulnerable
Philippine small-disked frog	Limnonectes parvus	The Philippine small-disked frog is a species of frog in the Dicroglossidae family. It is endemic to the Philippines. Its natural habitats are subtropical or tropical moist lowland forests, subtropical or tropical moist montane forests, and rivers. It is threatened by habitat loss.	Vulnerable
Mindanao horned frog or Southeast Asian horned toad	Megophrys stejnegeri	The Mindanao horned frog or Southeast Asian horned toad is a species of amphibian in the Megophryidae family. It is endemic to the Philippines. Its natural habitats are subtropical or tropical moist lowland forests, subtropical or tropical moist montane forests, rivers, and intermittent rivers. It is threatened by habitat loss	Vulnerable
The giant scops owl, lesser eagle-owl, or Mindanao eagle-owl	Otus gurneyi	The giant scops owl, lesser eagle-owl, or Mindanao eagle-owl is a species of owl in the family Strigidae. It is endemic to the Philippines. In size and structure, it is considered intermediate between a scops owl and an eagle-owl. Its natural habitat is subtropical or tropical moist lowland forests. It is threatened by habitat loss.	Vulnerable
Mindanao brown dove	Phapitreron brunneiceps	The Mindanao brown dove is a threatened species of bird in the family Columbidae. It is endemic to forests on the Philippine islands of Mindanao and Basilan, but it has not been recorded from the latter island since 1937. It is threatened by habitat loss and hunting. Until recently, it was considered conspecific with the Tawitawi brown dove and	Vulnerable

Common Name	Scientific Name	Description	Status
		collectively called the dark-eared brown dove.	
Mindanao treeshrew	Urogale everetti	The Mindanao tree shrew, also called the Philippine tree shrew, is a species of treeshrew endemic to the Mindanao region in the Philippines. It is the only member of the genus Urogale. The scientific name commemorates British colonial administrator and zoological collector Alfred Hart Everett	Vulnerable
N/A	Hemicordulia apoensis	Hemicordulia apoensis is endemic to the Philippines and is probably confined to the Mount Apo area on Mindanao. The species has been recorded only in areas actually within the central part of the mountain. It has been recorded in five sites which are all close to each other. Based on current data, the area of occupancy is less than 500 km², but it is hoped that the species will be found in other areas as field surveys continue. Its extent of occurrence is definitely less than 5,000 km². Hemicordulia apoensis is confined to the area surrounding Mount Apo on the Philippine island of Mindanao. Due to this restricted range, less than five locations known and ongoing habitat degradation (even though the area is officially designated as a protected area) the species qualifies for an Endangered listing.	Vulnerable
N/A	Philautus Surrufus	This species is currently known from a few mountains on north-western Mindanao Island, in the Philippines. Listed as Endangered because its Extent of Occurrence is less than 5,000 km, its distribution is severely fragmented, and there is continuing decline in the extent and quality of its habitat on Mindanao in the Philippines.	Endangered

Source: Inside Filipino Eden, https://www.insidefilipinoeden.com/region11-wildlife

(2) Trees in Magsaysay Memorial Park

Table 2.6 (1)-2.6(9) show tree inventory at the Magsaysay Park.

Table 2.6 (1) Tree inventory at Magsaysay Park (Nursery Area)

Pieces	Specie	Dimension		Volume	Remarks/ Recommendation
		Dia. (cm)	Ht. (m)	(cu.m)	
-Starts from	Kitchen & Mess Hall				
7	Molave	8	2.5	.06	Preserve
3	Ayanguille	6	2.0	.01	-do-
2	Fire tree	90	3.0	2.41	w/ 2 primary branches trimming & planning
1	Fire tree	60	3.0	.54	-do-
2	Coconut tree	50	3.5	.87	Preserve
1	Molave	18	3.0	.05	-do-
2	Fire tree	50	3.5	.87	-do-
1	Ayanguille	8	2.5	.01	-do-
1	Fire tree	90	3.0	1.21	w/3 primary branches trimming & pruning
1	Fire tree	90	3.5	1.41	-d0-
1	Fire tree	100	3.0	1.49	-do-
1	Fire tree	100	3.5	1.74	-do-
1	Mango	90	3.5	1.41	-do-
1	G. Neem tree	100	3.5	1.74	-do-
1	Narra	14	3.0	.03	-do-
1	Mango	18	2.5	.04	-do-
1	G. Neem tree	8	3.0	.01	-do-
1	Mango	6	2.0	.003	Preserve
1	Narra	30	2.0	.09	w/2 primary branches trimming & Pruning
1	Fire tree	120	3.0	2.14	-do-
31pcs				16.133m^3	

Source: Davao City

Table 2.6 (2) Tree inventory at Magsaysay Park (C.R and Monument Area)

Pieces	Specie	Dimension		Volume	Remarks/ Recommendation
		Dia.(cm)	Ht (m)	(cu.m)	
-Starts from	Material Recovery Facility (MRF)				w/2 primary branches
1	Fire tree	90	3.0	1.21	Trimming & Pruning
1	Mahogany	90	4.0	1.61	-do-
1	Ayanguille	40	4.0	.32	-do-
1	Ayanguille	14	3.0	.03	-do-
1	Ayanguille	20	3.5	.07	-do-
5	Ayanguille	8	2.5	.05	-do-
1	Ayanguille	18	2.5	.04	-do-
1	Mahogany	100	5.0	2.48	-do-
2	Ayanguille	20	2.5	.10	-do-
6	Ayanguille	6	2.0	.02	Preserve
1	Ayanguille	8	3.0	.01	-do-
1	Mahogany	24	4.0	.11	-do-
1	Fire tree	100	4.0	1.98	Trimming & Pruning
1	Mango	10	2.5	.01	Preserve
1	Talisay	100	5.0	2.48	Trimming& Pruning
1	Fire tree	60	5.0	.89	-do-
1	Fire tree	100	4.0	1.98	-do-
1	Molave	60	4.0	.71	-do-
1	Acacia	20	2.5	.05	Preserve
1	Molave	80	4.0	1.27	Trimming & Pruning
3	Ayanguille	20	2.0	.01	Preserve
1	Golden Shower	50	3.0	.06	Trimming & Pruning
1	Fire tree	80	2.0	.25	-d0-
1	Fire tree	90	3.0	1.91	-do-
1	Fire tree		2.5	1.00	-d0-
21 pcs.				18.85 m^3	

Source: Davao City

Table 2.6 (3) Tree inventory at Magsaysay Park (Amphi Theater & Seaside Area)

Pieces	Specie	Dimension		Volume	Remarks/ Recommendation
		DIA (cm)	HT. (IU)	(cu.m)	
-Starts at the	Junction of Amphi Theatre & Monument				
2	Coconut	60	4.0	1.42	Preserve
1	Molave	60	3.5	.63	Trimming & Pruning
1	Mahogany	10	3.0	.01	Preserve
3	Mahogany	10	2.5	.04	-do-
1	Narra	6	2.0	.003	-do-
1	Coconut	40	3.0	.24	-do-
3	Mahogany	18	3.0	.14	-do-
1	Molave	20	3.0	.06	-do-
1	Ficus	60	3.0	.54	Trimming & pruning
1	Ayanguille	18	2.5	.04	Preserve
1	Ayanguille	8	2.5	.09	-do-
1	Ayanguille	12	2.5	.02	-do-
3	Molave	18	3.0	.14	-do-
5	Ayanguille	10	2.5	.06	-do-
3	Molave	20	3.0	.19	-do-
1	Neem tree	10	2.0	.01	-do-
1	Neem tree	50	2.0	.25	Trimming & Pruning
1	Talisay	90	3.0	1.21	-do-
1	Molave	18	3.0	.05	Preserve
1	Coconut	50	3.0	.37	-do-
1	Molave	60	3.0	.54	Trimming & Pruning
1	Talisay	190	3.5	1.74	-do-
6	Coconut	50	3.0	2.23	Preserve
1	Molave	60	2.5	2.0	-do-
1	Firetree	40	2.5	.20	Trimming & Pruning
1	Molave	90	4.0	1.61	-do-
1	Molave	6	2.0	.004	Preserve

1	Molave	50	3.0	.37	Trimming & Pruning
1	Acacia	30	3.0	.13	Preserve
3	Molave	20	2.5	.30	-do-
1	Ayanguille	20	3.0	.06	-do-
1	Molave	50	3.0	.37	Trimming & Pruning
1	(Nuestra Señora Del Pilar)				Preserve
1	Acacia	20	2.5	.05	-do-
6	Ayanguille	20	3.0	.06	-do-
1	Palmera	8	2.0	.04	-do-
1	Molave	8	2.0	.006	-do-
1	Nipa	80	1.0	.32	-do-
1	Coconut	30	2.0	.09	-do-
1	Yuca Palm	20	3.0	.06	Trimming & Pruning
1	Molave	60	4.0	.71	-do-
3	Yuca Palm	60	2.0	.36	Preserve
1	Acacia	10	2.5	.04	-do-
	Yuca Palm	16	2.0	.03	
80Pcs.				15.113m^3	

Source: Davao City

Table 2.6 (4) Tree inventory at Magsaysay Park (Skating Rink Area -1)

Pieces	Specie	Dimension		Volume	Remarks/ Recommendation
		DIA.(cm)	HT.(IU)	(cu.m)	
1	Calachuchi	80	2.5	.32	Trimming & Pruning
1	Molave	60	4.0	.71	-do-
1	Mahogany	10	2.5	.01	-do-
1	Calachuchi	14	2.5	.02	-do-
1	Calachuchi	18	2.0	.03	-do-
1	Acacia	80	4.0	1.27	-do-
1	Calachuchi	14	2.0	.02	-do-
1	Mango	12	2.5	.02	-do-
1	Mahogany	20	4.0	.08	-do-
1	Molave	100	4.0	1.98	-do-
1	Mahogany	70	4.0	.97	-do-
2	Mahogany	60	4.0	.71	-do-
1	Mahogany	90	4.0	1.61	-do-
2	Mahogany	60	4.0	1.42	-do-
1	Calachuchi	20	2.0	.04	-do-
3	Mahogany	20	4.0	.24	-do-
4	Calachuchi	10	2.0	.04	-do-
1	Ficus	40	3.5	.28	-do-
1	Yuca Palm	14	2.0	.02	-do-
1	Mahogany	14	2.5	.02	-do-
2	Ficus	18	2.5	.04	-do-
5	Mahogany	10	2.5	.06	-do-
3	Ficus	40	2.5	.60	-do-
1	Calachuchi	10	2.0	.01	-do-
3	Mahogany	30	4.0	.54	-do-
1	Calachuchi	20	2.0	.04	-do-
2	Royal Palm	70	6.0	2.92	-do-
1	Molave	30	3.0	.13	-do-
45pcs.				14.15m^3	

Source: Davao City

Table 2.6 (5) Tree inventory at Magsaysay Park (Skating Rink Area-2)

Pieces	Specie	Dimension		Volume	REMARKS/ Recommendation
		DIA. (CM)	HT. (IU)	(CU.M)	
1	Molave	6	2.0	.004	Trimming & Pruning
1	Ayanguile	8	2.5	.008	-do-
1	Molave	10	2.5	.01	-do-
1	Molave	40	3.0	.24	-do-
1	Calachuchi	10	2.0	.009	-do-
1	Mango	20	2.5	.05	-do-
2	Travellers Palm	20	5.0	.10	-do-
1	Phoenix Palm	6	1.0	.002	-do-
1	Calachuchi	10	2.5	.01	-do-
1	Yuca	50	3.0	.37	-do-
1	Ayanguile	120	5.0	3.57	-do-
1	Yuca	60	3.0	.54	-do-
13pcs.				4.913m^3	

Source: Davao City

Table 2.6 (6) Tree inventory at Magsaysay Park (COMELEC AREA)

Pieces	Specie	Dimension		Volume	Remarks/ Recommendation
		DIA. (cm)	HT.(IU)	(cu.m)	
1	Neem Tree	14	2.5	.02	Preserve
1	Mahogany	20	3.0	.06	-do-
1	Ficus	60	3.0	.54	Trimming & Pruning
6	Coconut	50	3.0	2.23	Preserve
1	Molave	40	2.5	.20	-do-
1	Mahogany	40	3.0	.24	-do-
1	Fire tree	80	3.0	.95	Trimming & Pruning
1	Calachuchi	14	2.5	.02	Preserve
1	Neem tree	70	3.0	.73	Trimming & Pruning
1	Calchuchi	18	2.0	.03	Preserve
1	Mahogany	60	3.0	.54	Trimming & Pruning
1	Neem tree	70	3.0	.73	-do-
1	Ficus	90	2.0	.80	-do-
1	Narra	60	3.0	.54	-do-
3	Neem tree	40	2.5	.60	-do-
2	Neem tree	10	2.0	.01	Preserve
7	Talisay	20	3.0	.42	-do-
3	Neem tree	60	3.0	.54	Trimming & Pruning
1	Neem tree	18	2.0	.03	Preserve
1	Mango	20	2.5	.05	-do-
12	Calachuchi	10	2.0	.01	-do-
1	Mahogany	10	2.0	.02	-do-
1	Molave	10	2.0	.01	-do-
1	Coconut	20	3.0	.06	-do-
2	Mahogany	60	3.5	.63	Trimming & Pruning
1	Palmera	8	2.0	.012	Preserve
1	Coconut	40	3.0	.24	-do-
1	Indian Tree	10	2.0	.01	-do-
1	Talisay	40	3.0	.24	-do-
1	Neem tree	80	3.0	.95	Trimming & Pruning
1	Molave	10	2.0	.01	Preserve
2	Molave	30	3.5	.31	-do-
1	Ayanguille	18	2.0	.03	-do-
1	Mango	80	3.5	1.11	Trimming & Pruning
53pcs.				12,922m^3	

Source: Davao City

Table 2.6 (7) Tree inventory at Magsaysay Park (Davao City Investment Promotion office)

Pieces	Specie	Dimension		Volume	Remarks/ Recommendation
		Dia.(cm)	HT.(UI)	(CU.M)	
1	G. Neem tree	60	2.5	.45	Trimming & Pruning
2	Coconut	20	2.5	.10	Preserve
3	Coconut	40	4.0	.95	-do-
1	Narra	70	3.5	.85	Trimming & Pruning
27	Palmera	6	2.0	.10	Preserve
1	Mango	60	2.0	.36	-do-
1	Jackfruit	30	2.5	.11	-do-
1	Neem tree	90	3.0	1.21	Trimming & Pruning
2	Neem tree	70	2.5	1.22	-do-
1	Neem tree	80	2.5	.79	-do-
2	Neem tree	90	3.0	2.41	-do-
1	Neem tree	90	3.0	1.21	-do-
1	Neem tree	80	2.5	.79	-do-
1	Neem tree	14	2.5	.02	-do-
4	Neem tree	60	2.5	1.79	-do-
1	Neem tree	40	2.5	.20	-do-
1	Neem tree	90	2.5	1.00	-do-
1	Neem tree	50	2.0	.25	-do-
1	Neem tree	60	2.0	.36	-do-
1	Neem tree	60	3.0	.54	-do-
2	Molave	10	2.0	.02	Preserve
56 pcs.				14.73m^3	

Source: Davao City

Table 2.6 (8) Tree inventory at Magsaysay Park (Ancillary Service Unit Area)

Pieces	Specie	Dimension		VOLUME	Remarks/ Recommendation
		DIA (cm)	HT. (IU)	(CU.M)	
1	Neem tree	110	5.0	3.00	Trimming & Pruning
1	Talisay	6	1.0	.002	Preserve
1	Molave	90	4.0	1.61	Trimming & Pruning
1	Calachuchi	10	1.0	.005	Preserve
1	Molave	18	2.5	.04	-do-
9	Molave	10	3.0	.13	-do-
4	Molave	8	2.0	.03	-do-
1	Calachuchi	18	2.0	.03	-d0-
1	Neem tree	120	5.0	3.57	Trimming & Pruning
1	Molave	90	4.0	1.61	-do-
1	Ayanguille	18	4.0	.06	Preserve
2	Molave	6	2.0	.007	-do-
1	Ficus	8	2.0	.03	-do-
1	Neem tree	110	5.0	3.00	Trimming & Pruning
1	Neem tree	50	4.0	.50	-do-
27 pcs.				13.624m^3	

Source: Davao City

Table 2.6 (9) Tree inventory at Magsaysay Park (Entrance Gate)

Pieces	Specie	Dimension		VOLUME	Remarks/ Recommendation
		DIA (cm)	HT.(IU)	(CU.M)	
2	Molave	30	3.5	.31	Trimming/Pruning/Preserve
1	Molave	18	3.0	.05	- do-
1	Mango	18	2.5	.04	-do-
1	Narra	70	3.5	.85	-do-
1	Molave	20	3.0	.06	-do-
1	Narra	18	3.0	.05	-do-
1	Mango	20	2.5	.05	-do-
1	Narra	60	3.0	.54	-do-
1	Molave	14	2.0	.02	-do-
1	Golden shower	10	2.5	.01	-do-
1	Neem tree	18	2.5	.04	-do-
1	Molave	10	2.5	.01	-do-
1	Golden shower	10	2.5	.01	-do-
3	Mango	40	3.0	.71	-do-
2	Neem tree	30	3.0	.26	-do-
1	Narra	6	2.0	.003	-do-
1	Molave	6	2.0	.003	-do-
3	Neem tree	30	3.0	.40	-do-
1	Molave	14	2.0	.02	-do-
1	Bagras	30	4.0	.18	-do-
3	Neem tree	50	2.5	.31	-do-
1	Neem tree	20	2.5	.05	-do-
30pcs.				3.976m^3	

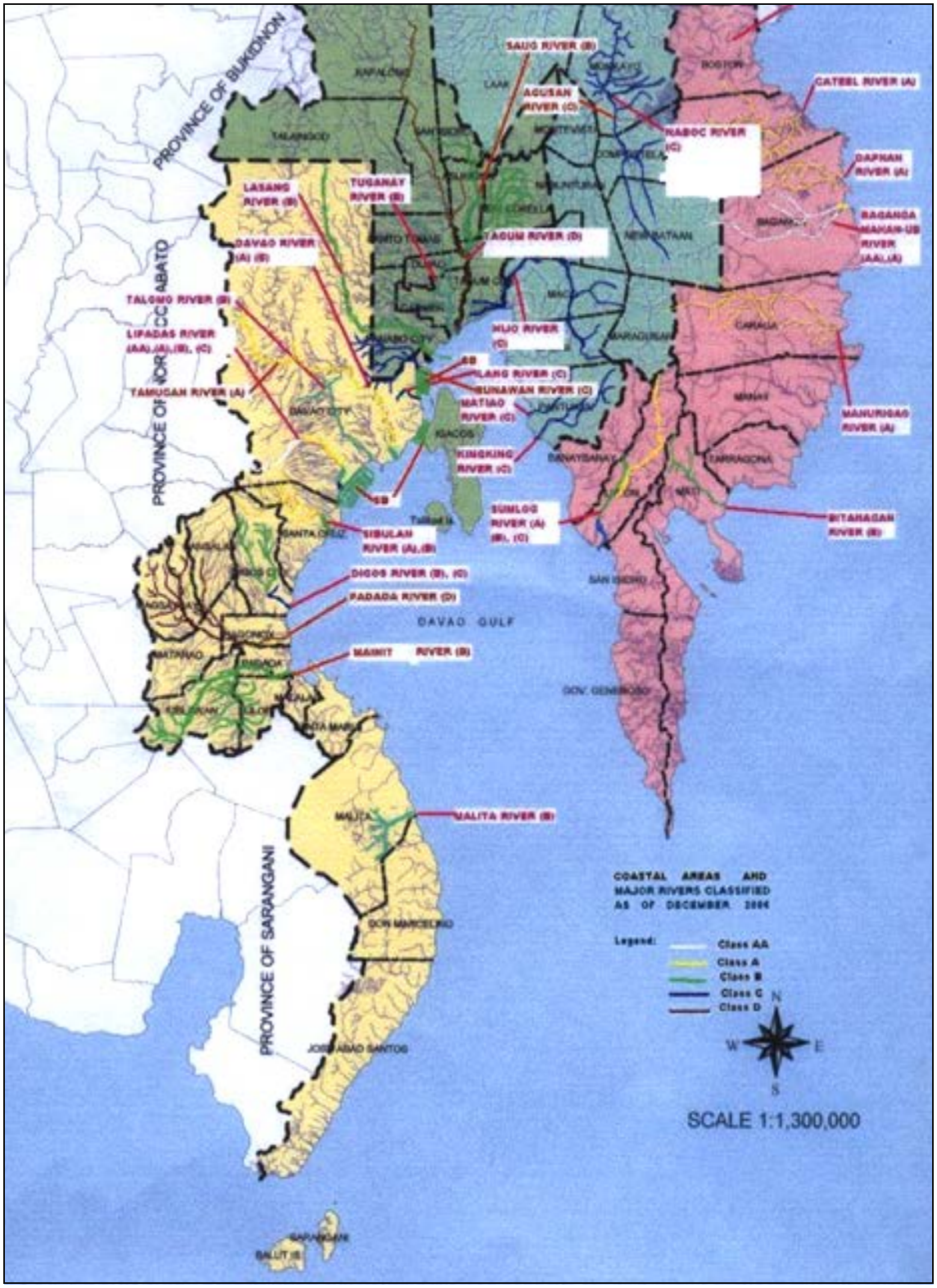
Source: Davao City

2.6 Hydrology

Figure 2.2 shows the Davao Regional Map of Water Bodies Classified by DENR. As regard the classification, Section 5.0 at DAO 2016-08 stipulates the Water Body Classification and Usage of Freshwater as shown Table 2.7.

Among those, main rivers in Davao City is summarized based on the DENR classification (DAO 2016-08) in Table 2.8.

In addition, Figure 2.3 and Figure 2.4 shows a map of the "Administrative Boundaries of Davao River Basin" and a map of the "River and Creeks in the Sewerage Development Area A" in Davao City respectively.



Source: Home Page of EMB Region XI (http://r11.emb.gov.ph/water-quality-management/)

Figure 2.2 Regional Map of Water Bodies Classified

Table 2.7 Water Body Classification and Usage of Freshwater

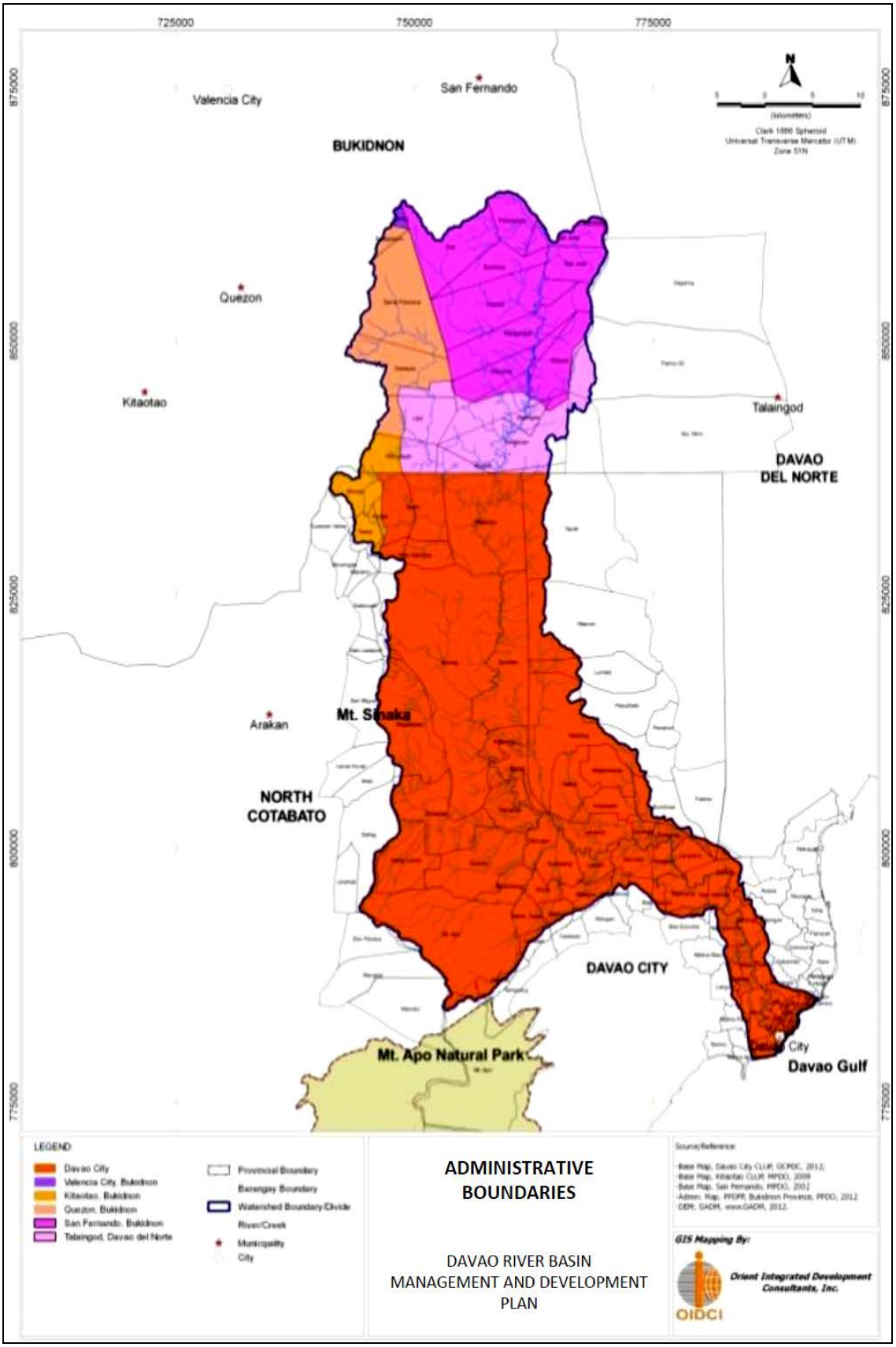
Classification	Beneficial Use
Class AA	**Public Water Supply Class I** Intended primarily for waters having watersheds which are uninhabited and/or otherwise protected areas and which require only approved disinfections to meet the latest PNSDW
Class A	**Public Water Supply Class II** Intended as sources of water supply requiring conventional treatment (coagulation, sedimentation, filtration & disinfection) to meet the latest PNSDW
Class B	**Recreational Water Class I** Intended for primary contact recreation (bathing, swimming, skin diving, etc.)
Class C	1) **Fishery Water** for the propagation and growth of fish and other aquatic resources; 2) **Recreational Water Class II** (boating, fishing, etc.) 3) For agriculture, irrigation & livestock watering.
Class D	Navigable waters

Source: DA0 2016-08 Section 5.0, EMB Region XI

Table 2.8 Hydrological Aspects in Davao City

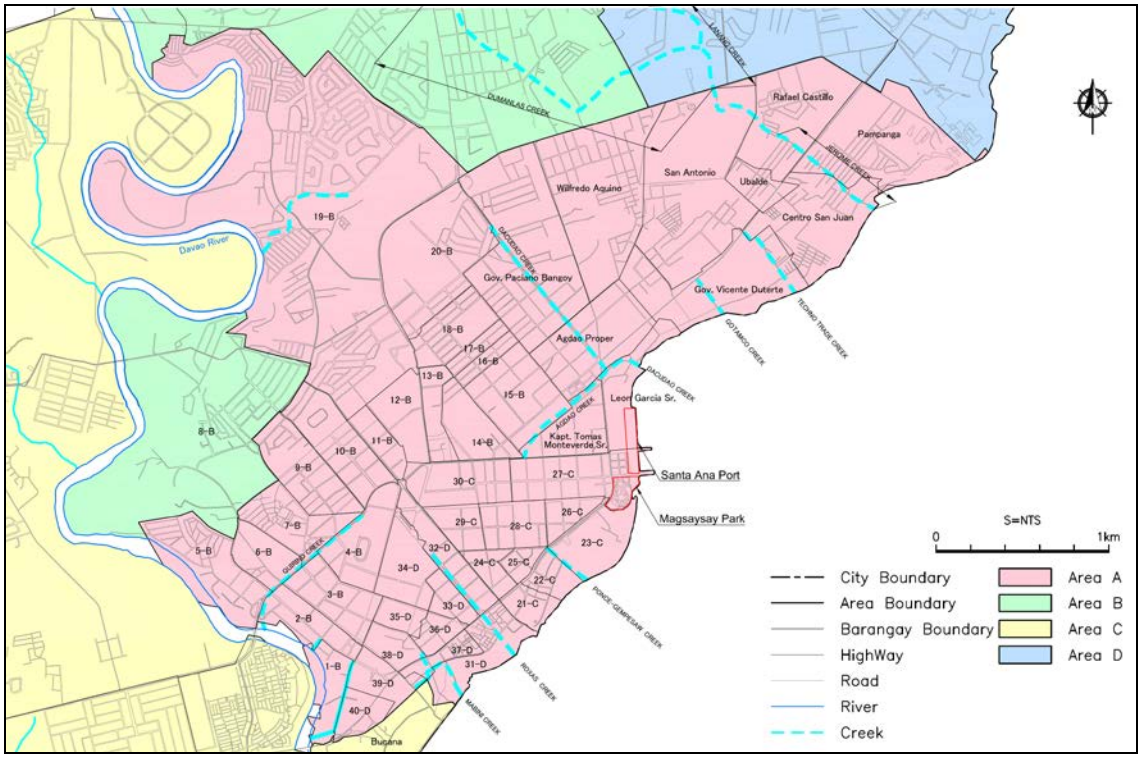
River	Classification
Bunawan River	Class C
Davao River	Class B- Sta. 1-4 (Downstream) Class A - Sta. 5-8 (Upstream)
Ilang River	Class C
Lansang River	Class B
Lipadas River	Class AA- Mt. Apo Nat'l Park to Brgy, Baracayo Class A - Bray, Baracayo to Brgy. Bangkas Class B - Midstream (Brg. Bankas to Brgy. Alambre) Class C- Downstream (Brgy. Alambre to confluence with Davao Gulf)
Talomo River	Class B

Source: Home Page of EMB Region XI (http://r11.emb.gov.ph/water-quality-management/)



Source: Volume 1 Executive Summary, Davao River Basin Management and Development Plan, Feb. 2015, DENR

Figure 2.3 Administrative Boundaries of Davao River Basin



Source: JICA Survey Team based on Davao City and DPWH data

Figure 2.4 River and Creeks in the Sewerage Development Area A in Davao City

3. Social Conditions

3.1 Demographic Situation and Community

(1) Population

According to Davao City, the population of Davao City is more than 1.67 million people at present with 11 ethnics groups. Table 3.1 shows population of Davao City by District.

Table 3.1 Population of Davao City by District

Congressional District	Administrative District	No. of Barangays	No. of HHs, 2015	Total Population by Census Year			Annual Ave. Growth (%)	
				2000	2010	2015	2000–2010	2010–2015
1	Poblacion	40	43,712	133,639	156,450	174,121	1.6	2.2
	Talomo	14	105,090	284,100	382,652	418,615	3.0	1.8
2	Agdao	11	25,673	91,397	99,406	102,267	0.8	0.6
	Buhangin	13	73,585	193,519	256,959	293,118	2.9	2.7
	Bunawan	9	38,185	97,641	103,615	152,102	0.6	8.0
	Paquibato	13	11,237	35,270	39,698	44,763	1.2	2.4
3	Baguio	8	8,503	24,379	30,384	33,873	2.2	2.2
	Calinan	19	23,115	67,077	81,844	92,075	2.0	2.4
	Marilog	12	13,105	42,736	45,125	52,201	0.5	3.0
	Toril	25	37,285	108,054	133,452	148,522	2.1	2.2
	Tugbok	18	30,460	69,304	91,622	121,334	2.8	5.8
Davao City		**182**	**409,951**	**1,147,116**	**1,421,207**	**1,632,991**	**2.4**	**2.3**

Sources: Primary data from PSA and calculations for 2015 households used average household size of 4 persons.
Original Source: Primary data from PSA and calculations for 2015 households used average household size of 4 persons.
Source; Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

(2) Indigenous People

Davao City has a segment of 11 ethnic groups of Ethno-Linguistic Tribes as shown in Table 3.2.

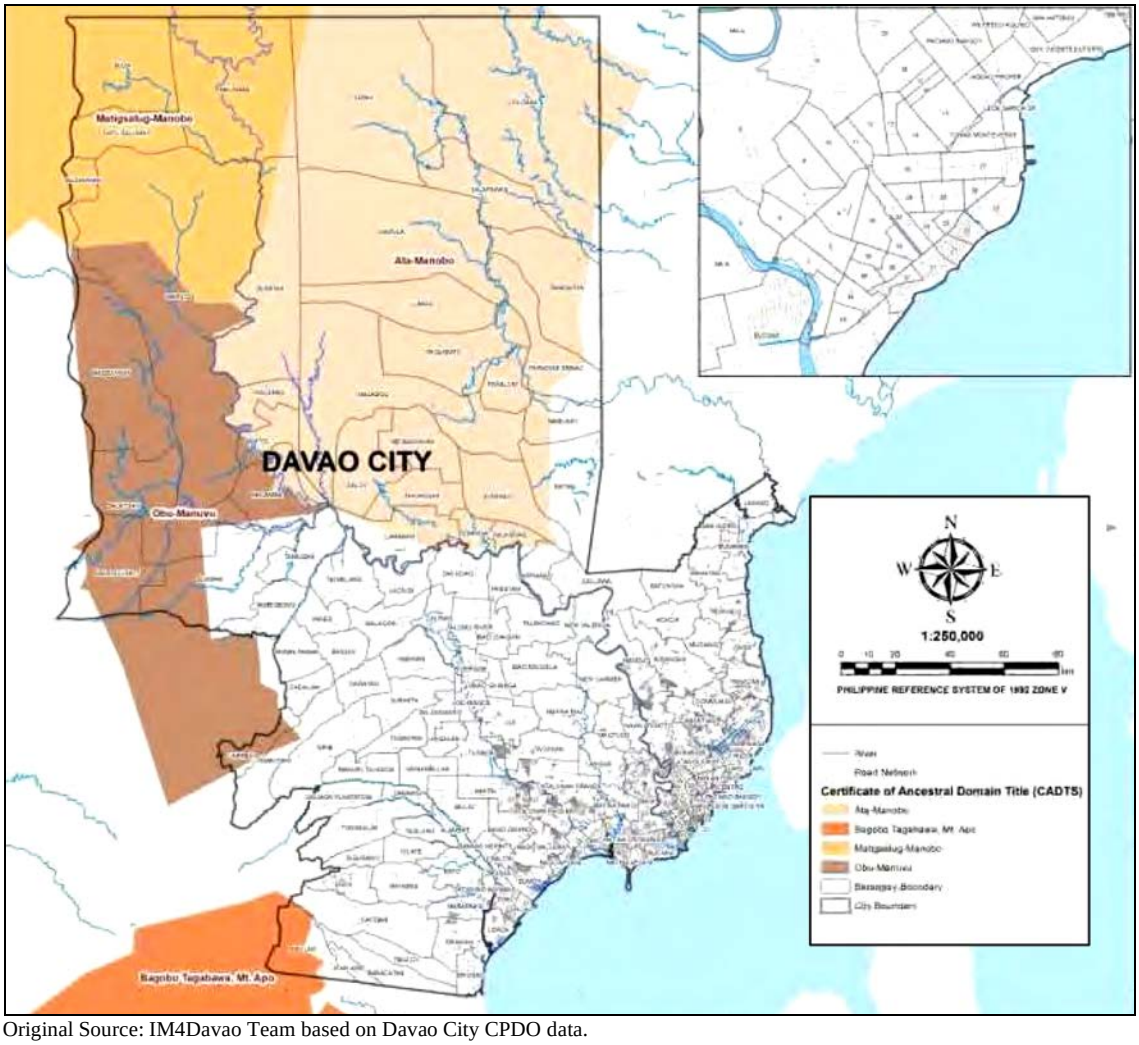
Table 3.2 Ethno-Linguistic Tribes in Davao City

Name of Tribes	Name of Tribes
Maranao	Kagan
Tausug	Tagabawa
Maguindanaon	Ovu-Manuvo
Iranun	Matigsalog
Sama	Klata-Guiangan
Ata	-

Source: Socio Economic Profile Davao City (https://www.davaocity.gov.ph/know-davao-city/socio-economic-profile/)

IM4D 2018 JICA summarizes the ethnic groups as follows.

- ✓ Population count is ongoing, but so far it has been recorded for three groups at approximately 66,000 (2010–2013).
- ✓ Although their population is small, they have rights over a large chunk of the city's land area of about 65% or 158,000 hectares, which represent their ancestral domain, as shown in Figure 3.1.



Original Source: IM4Davao Team based on Davao City CPDO data.
Source; Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

Figure 3.1 Ancestral Domain in Davao City

(2) Health

Table 3.3 and Table 3.4 shows leading causes of morbidity and mortality in Davao Region in 2015 respectively.

Table 3.3 Leading Causes of Morbidity, Davao Region, 2015

	DISEASES	MALE	FEMALE	TOTAL
1	Acute Upper Respiratory Tract Infection	28,379	33,140	61,519
2	Pneumonia	14,655	14,262	28,917
3	Disease of the Urinary System	6,573	10,799	17,372
4	Acute Respiratory Infection	6,995	7,798	14,793
5	Essential Hypertension	4,624	7,484	12,108
6	Diarrhea and Gastroenteritis	6,906	6,749	13,655
7	Wounds, all types	5,689	4,027	9,716
8	Acute bronchitis/ bronchiolitis	4,028	4,066	8,094
9	Other viral disease	2,276	2,237	4,513
10	Disease of the heart	2,575	2,792	5,367

Original Source: DOH
Source: Davao Regional Development Plan 2017-202, 2National Economic and Development Authority Regional Office X

Table 3.4 Leading Causes of Mortality, Davao Region, 2015

	DISEASES	MALE	FEMALE	TOTAL
1	Pneumonia	1,457	1,043	2,500
2	Diseases of the Heart	1,423	1,041	2,464
3	Cerebrovascular disease	1,017	770	1,787
4	Diabetes Mellitus	423	409	832
5	Hypertensive diseases	439	333	772
6	Diseases of the arteries, arterioles and capillaries	297	447	744
7	Renal failure	334	208	542
8	Chronic lower respiratory diseases	327	128	455
9	Septicemia	211	201	412
10	Tuberculosis	271	115	386

Original Source: DOH
Source: Davao Regional Development Plan 2017-202, 2National Economic and Development Authority Regional Office X

"Davao Regional Development Plan 2017-2022, NEDA Region XI" summarizes the health situation in Davao Region including Davao City as shown below.

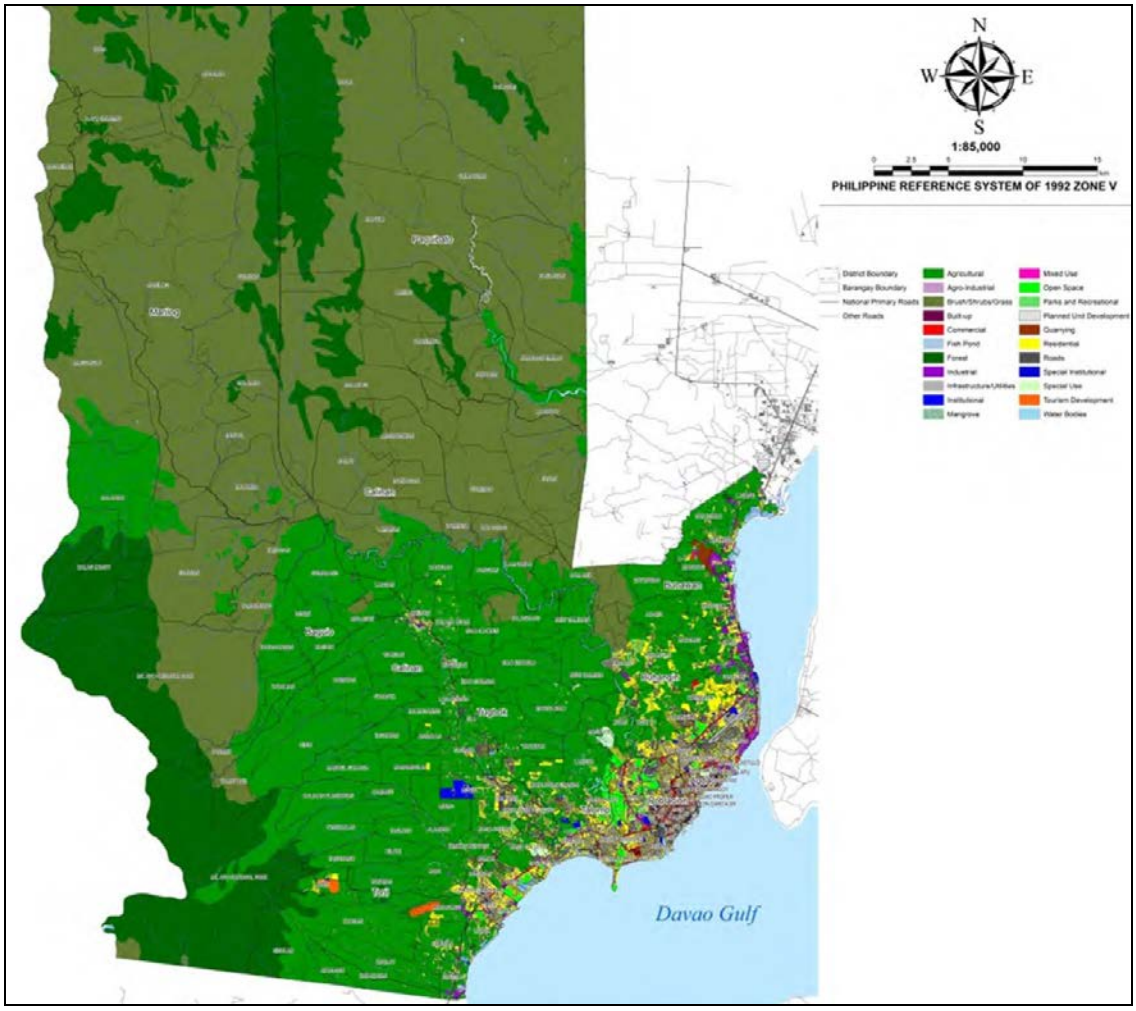
- ✓ On occurrence of diseases, tuberculosis prevalence was 244 per 100,000 population. This was highest in Davao del Norte (258) and Davao City (257). Meanwhile, Davao Region was the fifth highest among regions in terms of reported HIV-AIDS cases at 1,606 from January 2010 to November 2015. The incidence of malaria reached 2.43 in 2015, which was highest in Davao del Norte (10.94). Compostela Valley, Davao Oriental and Davao del Sur had zero incidences of malaria. Meanwhile, the Region's top causes of morbidity in 2015 were acute upper respiratory tract infection, pneumonia, disease of the urinary system, essential hypertension, diarrhea and gastroenteritis.
- ✓ On the other hand, the leading causes of mortality were pneumonia and heart and

cerebrovascular diseases. It can be noted that the number of affected females was higher compared to males in terms of morbidity or incidence of diseases, whereas the males had higher mortality rates or are more susceptible to death from such diseases than females.

3.2 Land Use

The land use of Davao City is summarized in IM4D as follows.

- ✓ Of Davao City's total land area of 244,000 ha, 15,772 ha or 7.2% is for urban use, i.e., residential, commercial, infrastructure/utilities, institutional, parks/recreation spaces, industrial, planned unit development (PUD), and open space (Figure 3.2).
- ✓ Brushland/Shrubs/Grassland has the highest share of 50.0% of the total land, followed by agricultural land (30.6%) and forest and forest use land (11.0%).
- ✓ Besides its large land area, Davao City has 415 ha of marine protected areas in barangays Bunawan, Centro, and Matina Aplaya, which are a combination of mangrove forests and fish sanctuaries.



Note: *Land use in rural areas was prepared by Davao City in 2011 and updated by the JICA Project Team
Source; Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

Figure 3.2 Updated Existing Land Use 2017*

✓ Table 3.5 shows a list of Area by Land Use Type and District in Davao City.

Table 3.5 Area by Land Use Type and District (2017)[1]

Land Use Category		Area by Land Use (ha)											Davao City	
		Poblacion	Talomo	Agdao	Buhangin	Bunawan	Paquibato	Baguio	Calinan	Marilog	Toril	Tugbok	Area (ha)	Share (%)
Urban Use	Residential	576	2,927	269	2,610	967	132	252	319	278	1,024	692	10,048	4.6
	Commercial	243	248	96	175	56	-	-	17	-	37	12	884	0.4
	Industrial	19	123	71	226	463	-	6	9	-	115	16	1,048	0.5
	Institutional	77	180	12	93	64	-	-	14	-	37	229	705	0.3
	Parks/Recreational	5	42	0.3	91	7	-	-	0.6	-	4	71	222	0.1
	Infrastructure/Utilities	141	516	53	596	159	-	1	51	-	201	143	1,861	0.8
	PUD	-	43	0.2	22	-	-	-	-	-	-	-	65	0.03
	Open Space	66	678	5	106	42	-	-	-	-	41	-	939	0.4
	Subtotal	**1,127**	**4,758**	**507**	**3,919**	**1,758**	**132**	**259**	**410**	**278**	**1,460**	**1,164**	**15,772**	**7.2**
Agricultural		-	3,614	-	4,136	4,265	1,650	6,134	12,577	5,990	15,665	13,086	67,116	30.6
Forest		-	-	-	-	-	10,464	66	924	11,069	1,500	-	24,023	11.0
Quarrying		-	-	-	-	139	-	-	-	-	-	-	139	0.06
Brushland/Shrubs/Grassland		-	2	-	1,419	2	52,647	1,578	8,463	45,237		299	109,648	50.0
Tourism Development		-	-	-	0.2	-	-	-	-	-	193	-	193	0.09
Special Use		23	217	25	13	4	-	-	25	-	8	12	327	0.1
Water Use	Fish Pond	-	14	-	-	60	-	-	-	-	19	3	96	0.04
	Mangrove	-	16	-	-	0.09	-	-	-	-	-	-	16	0.007
	Water Bodies	17	211	5	47	109	350	83	236	397	273	158	1,887	0.9
	Subtotal	**17**	**241**	**5**	**47**	**169**	**350**	**83**	**236**	**397**	**292**	**162**	**2,000**	**0.9**
Total [2]		**1,168**	**8,833**	**537**	**9,533**	**6,337**	**65,243**	**8,120**	**22,635**	**62,971**	**19,118**	**14,722**	**219,218**	**100.0**

Note 1 Land use in rural area was prepared by Davao City in 2011.
Note 2 Areas were calculated using GIS, and some water bodies are not located under any barangay/district. Therefore, the total area does not match the total area of Davao City (2440,000 ha).
Source; Davao City Infrastructure Development Plan and Capacity Building Project (IM4D), Final Report, June 2018, JICA

3.3 Heritage

In Davao Region, there are lots of natural and cultural (tangible and intangible) heritages which attract domestic and international tourists as shown in Figure 3.3.

Source: Culture & Heritage, Department of Tourism, Davao Region (http://www.davaotourism.ph/culture-heritage/)

Figure 3.3 Natural and Cultural Sites in Davao Region

Among those, Mount Apo is, a national park (Proclamation No. 59 in 1936 by the President) and a protected area of 6,354 acres including two peripheral areas and buffer zones (RA No. 9237 in 2004), the highest mountain (2,954 m above sea level) in the Philippines. IM4D explains the following event on Mount Apo.

- ✓ In 2009, the DENR submitted Mount Apo for inclusion in the UNESCO World Heritage list.
- ✓ The mountain is considered as the center of endemism in Mindanao.
- ✓ In 2015, however, it was taken out from the UNESCO List of Tentative Sites due to its deteriorated environmental conditions brought about by logging, intrusion of companies, landscape changes, etc.

In addition, in Davao Region and Davao city there are several historical sites and structures listed by the National Historical Commission of the Philippines as shown in Table 3.6 ant Table 3.7.

Table 3.6 List of Historic Sites and Structures Installed with Historical Markers

No.	Region	Province/City	Title of Maker	Category	Type	Location	Date
316	XI	Davao del Norte	Davao Penal Colony	Site	Group of buildings	Carmen, Davao del Norte	1956
317	XI	Davao del Sur	Port Sta. Ana	Site	Site	Davao City	August 25, 2003

Source; Historic Preservation Division, National Historical Commission of the Philippines (as of January 16, 2012)

Table 3.7 National Registry of Historic Sites & Structures in the Philippines

Status	Title	Category	Type	Location	Marker Date
Level II - With Marker	Andres Bonifacio Monument	Structure	Monument	Davao City	2013
Level II - With Marker	Davao City Hall	Building	Government Center	Davao City	2012
Level II - With Marker	Simbahan ng Caraga	Building	House of Worship	Caraga, Davao Oriental	July 16, 2012
Level II - With Marker	Ohta Kyozaburo Monument	Personage	Monument	Mintal, Davao City	2003

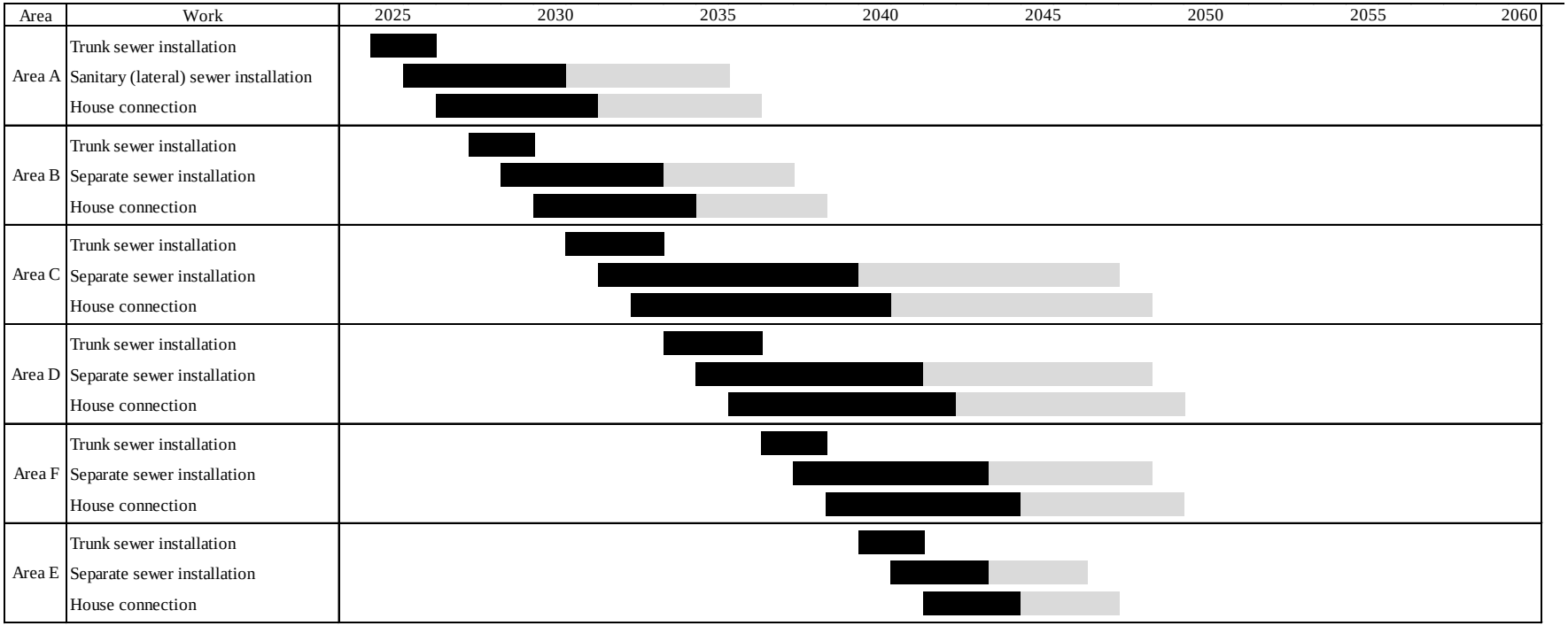
Source; National Historical Commission of the Philippines

APPENDIX 5.5_DEVELOPMENT PERIODS OF SEPARATE SEWER SYSTEM AND COMBINED SEWER SYSTEM

The target year is 2045 based on IM4D, in which the sewerage system will be completed in Davao City.

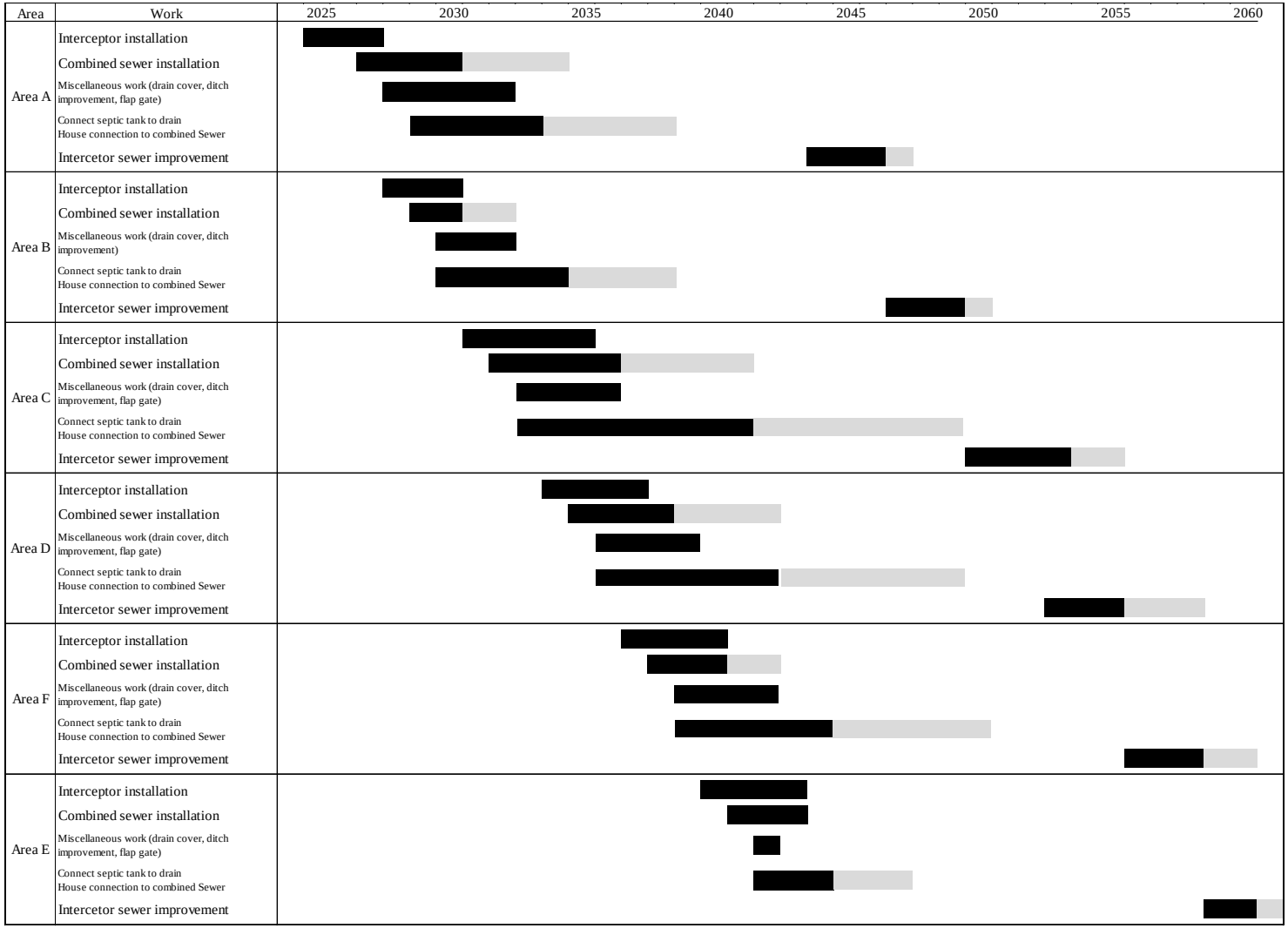
Therefore, in either case that separate sewer system will be introduced or that the combined sewer system will be introduced, the generated wastewater will be collected and treated in STPs at the time of fine weather after 2045. Although existing septic tanks and septage treatment systems will be utilized at an early stage.

However, if the target level to mitigate the pollution load on public bodies of water is the same level as the separate sewer system, additional structures and facilities as countermeasures against combined sewage overflow are necessary to be developed after the completion of combined sewer system. Therefore, the required period to achieve the target level with a combined sewer system will be much longer than the case of a separate sewer system as shown in Figure 5.3.4 and Figure 5.3.5. In addition, the countermeasures become difficult and more costly due to the limited space for facilities in the future.



Note: Gray bars show the contingency period for delay of works such as house connections
Source: JICA Study Team

Figure A5.5.1 Image of Step-wise Sewerage Development with Separate Sewer System



Note: Gray bars show the contingency period for delay of works such as house connections
Source: JICA Survey Team

Figure A5.5.2 Image of Step-wise Sewerage Development with Combined Sewer System

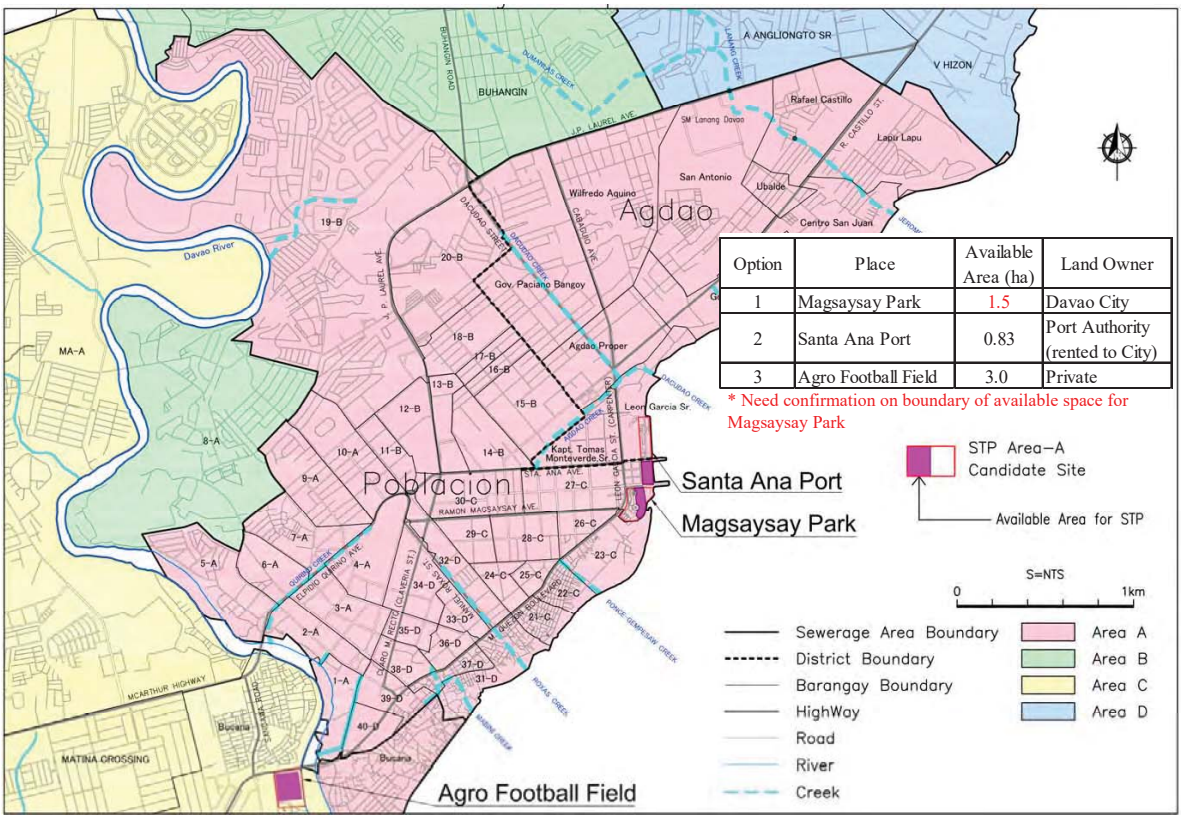
Data Collection Survey for Sewerage System Development in Davao City

Comparison of STP Area-A Sites (Reference Figures and Confirmation)

18th June, 2019

JICA Study Team

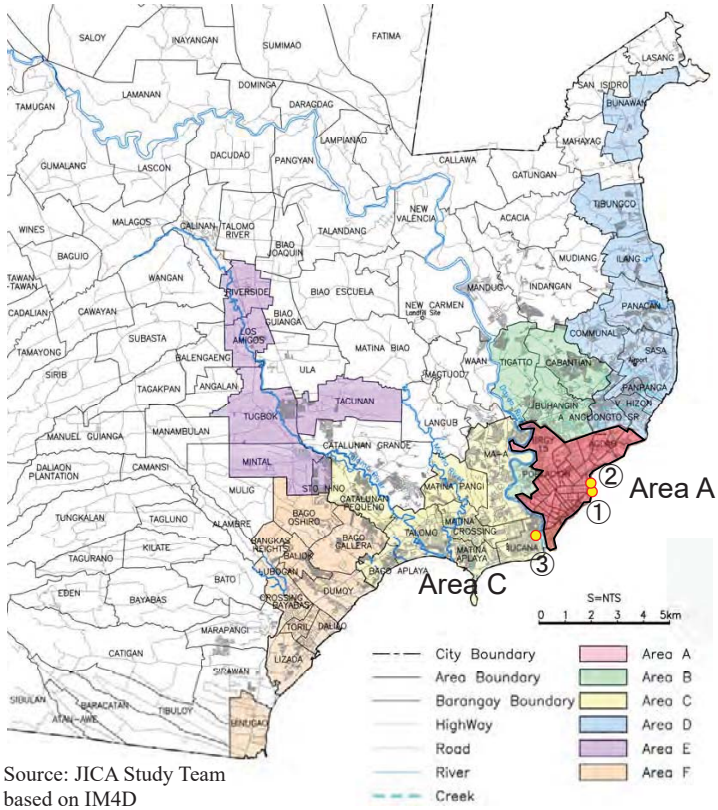
1 Candidate Sites and preliminary layout for STP (Location Map of Three Candidate Sites)



Option	Place	Available Area (ha)	Land Owner
1	Magsaysay Park	1.5	Davao City
2	Santa Ana Port	0.83	Port Authority (rented to City)
3	Agro Football Field	3.0	Private

* Need confirmation on boundary of available space for Magsaysay Park

1 Candidate Sites and preliminary layout for STP (Location Map of Three Candidate Sites)



Source: JICA Study Team based on IM4D

Location of Candidate Sites in Entire Sewerage Area in IM4D

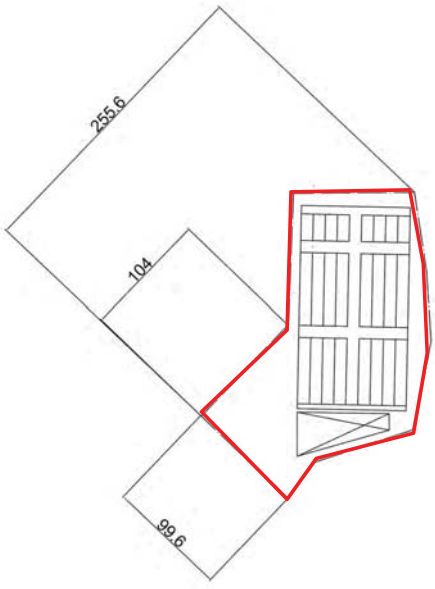
Option	Place	Available Area (ha)	Land Owner
1	Magsaysay Park	1.5	Davao City
2	Santa Ana Port	0.83	Port Authority (rented to City)
3	Agro Football Field	3.0	Private

* Need confirmation on boundary of available space for Magsaysay Park

2 Candidate Sites and preliminary layout for STP (1. Magsaysay Park)

Advantage: Purely City's Property

Conventional Activated Sludge (CAS) with Biological Nutrient Removal (BNR): 100,000 m3/day

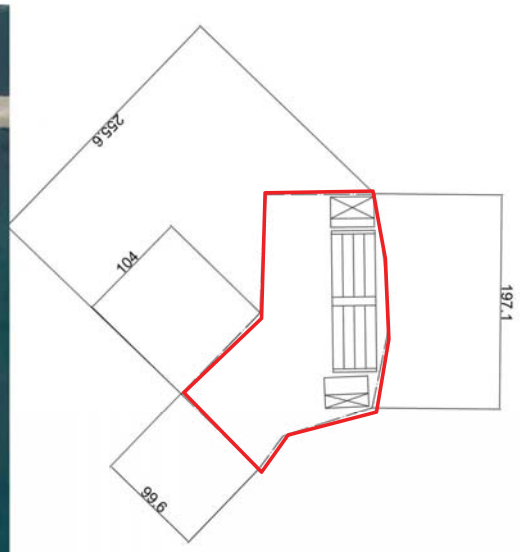


Occupy large area and monuments shall be removed.

Source: JICA Study Team on Google Earth

2 Candidate Sites and preliminary layout for STP (1. Magsaysay Park)

Membrane Bio Reactor (MBR) with BNR: 100,000 m3/day (Layout Pattern-1)



Monuments can be kept as existing status

Source: JICA Study Team on Google Earth

2 Candidate Sites and preliminary layout for STP (1. Magsaysay Park)

Existing Structures in Magsaysay Park

No.	Existing Structure
1	Ramon Magsaysay Monument
2	Flag Pole
3	Covered Amphi Theatre
4	Tribe Houses
5	Parking Area (Planned Parking Building)
6	Temporary Building (Field Service Extension Office No.11)
7	Building (Davao City Investment Promotion Center)
8	Ang Napulo Ka Sugo Sa Dios (chapel?)
9	Small play equipment for kids

Source: JICA Study Team based on Magsaysay Park Plan by City Architect

2 Candidate Sites and preliminary layout for STP (1. Magsaysay Park)

		
1. Ramon Magsaysay Monument	2. Flag Pole	3. Covered Amphi Theatre
		
4. Tribe Houses	6. Temporary Building (Field Service Extension Office No.11)	8. Ang Napulo Ka Sugo Sa Dios (chapel?)

Source: JICA Study Team

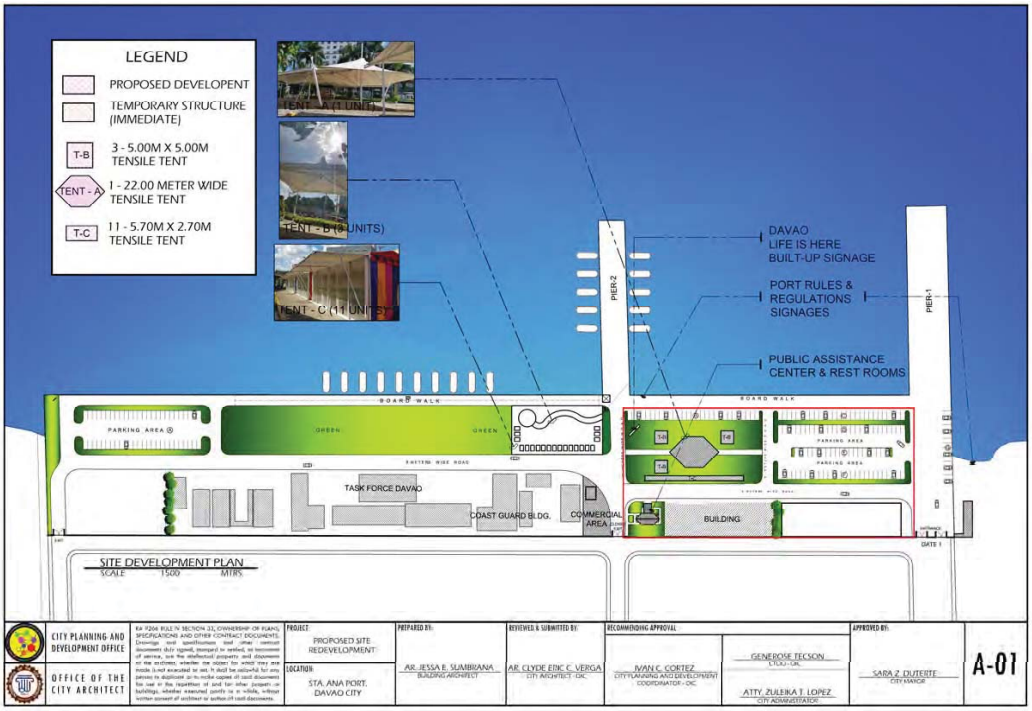
2 Candidate Sites and preliminary layout for STP (1. Magsaysay Park)

Once Magsaysay Park would be finally selected as STP site, let us confirm about possibility of demolishment/temporary removal/move of each existing structure

No.	Existing Structure	Demolishment	Temporary Removal /Recovery	Move
1	Ramon Magsaysay Monument	Not OK	Not OK	Not OK
2	Flag Pole			
3	Covered Amphi Theatre			
4	Tribe Houses			
5	Parking Area (Planned Parking Building)			
6	Temporary Building (Field Service Extention Office No.11)			
7	Building (Davao City Investment Promotion Center)			
8	Ang Napulo Ka Sugo Sa Dios (chapel?)			
9	Small play equipment for kids			
10	Trees			

3 Candidate Sites and preliminary layout for STP (2. Santa Ana Port Park)

Reference: Proposed Development of Santa Ana Port by City Architect (as of end of 2018)



Source: City Architect

Future procedure on ownership and rental of land

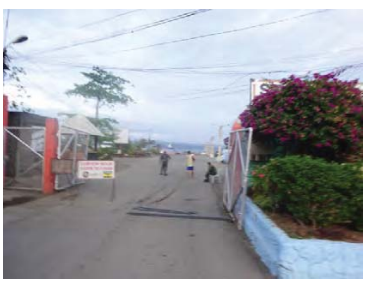
3 Candidate Sites and preliminary layout for STP (2. Santa Ana Port Park)

Existing Condition of Santa Ana Port

Advantage: Much open space

West (Open)

East (Tent)



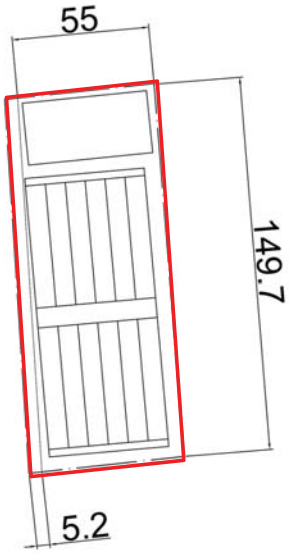
Entrance

Southeast (Parking)

Seaside

3 Candidate Sites and preliminary layout for STP (2. Santa Ana Port Park)

Membrane Bio Reactor (MBR) with BNR: 100,000 m3/day



3 Candidate Sites and preliminary layout for STP (2. Santa Ana Port Park)

Davao City Coastal Road Alignment (DPWH)

Source: DPWH

Need coordination with DPWH by Davao City to change the alignment (scheduled to be held on June 11)

4 Candidate Sites and preliminary layout for STP (3. Magsaysay Park and Santa Ana Port)

Example of Preliminary Layout for Magsaysay Park and Santa Ana Port

Source: JICA Study Team

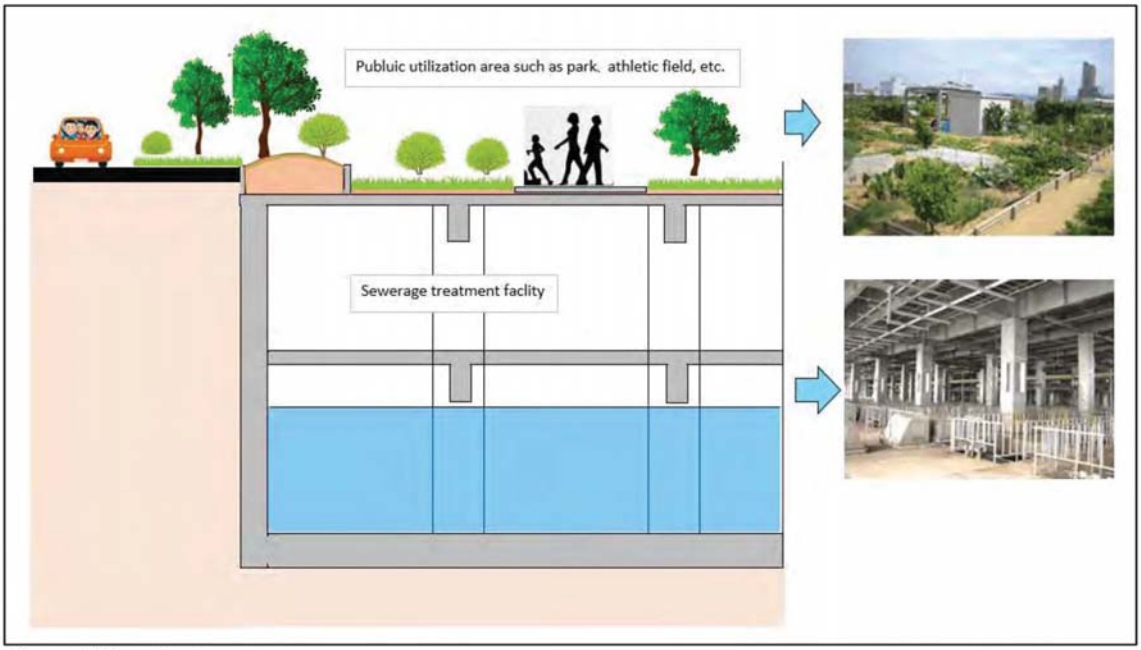
Use of Two Lands (Magsaysay Park and Santa Port) have following advantage;

1) Area for Septage Treatment Facility (SpTF) can be secured;

2) Occupied land in Magsaysay Park can be reduced.

3) In case of left side example, sludge transportation becomes easy as adjacent to road. * Once availability of land will be confirmed, several layouts will be compared and best option will be proposed.

5 Utilization of Ground on STP (Section of Full Underground Layout Case)



Source: IM4Davao Team

Figure 15.3.3 Conceptual Image of Sewerage Treatment Plant (full underground type)

※Sludge Treatment (Dewatering House) and Administration Building shall be On-ground

5 Utilization of Ground on STP (Example of Underground STP in Japan)

Example of Underground Sewage Treatment Plant in Japan

Case 1: Sewage Treatment Plant in Tokyo (76,000m3/day)	
Underground Plant (Red Area)	Facility on the Plant (Treated Water Lake in Park)
	
Case 2: Sewage Treatment Plant in West Japan (48,000m3/day)	
Underground Plant (Red Area)	Facility on the Plant (Treated Water Lake in Park)
	

APPENDIX 6.2.1_SELECTION OF MEMBRANE OF MBR PROCESS

There are two types of membranes, namely the hollow fiber membrane and the flat sheet membrane. Their wastewater treatment performance, e.g., flux, is almost the same; however, the necessary space, cost, and O&M procedures would vary depending on the membrane types. The details are described below.

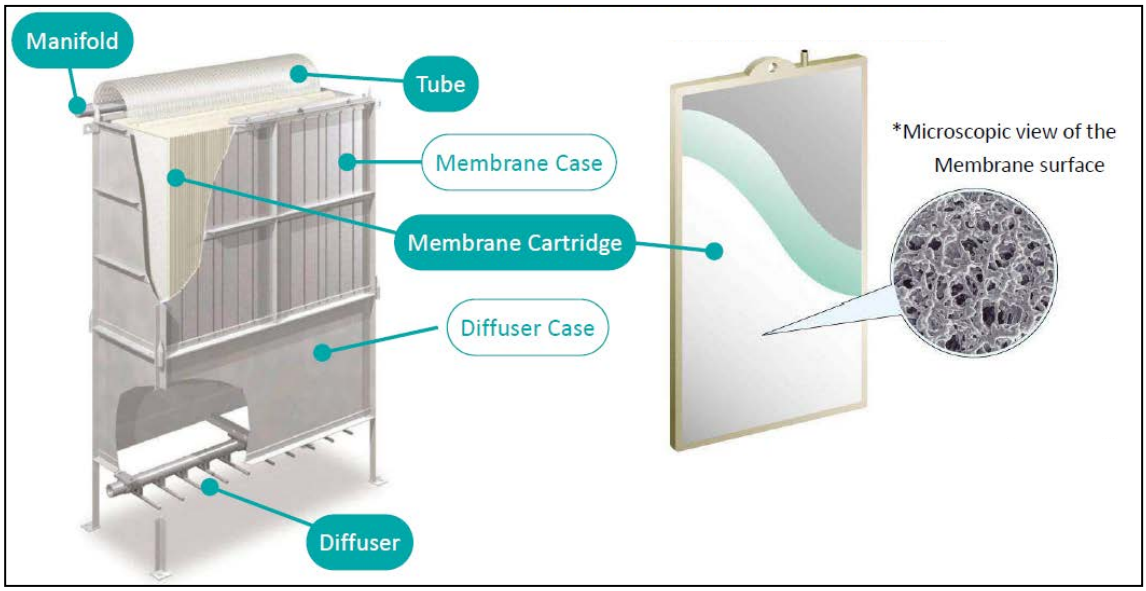
a) Flat Sheet Membrane

The membrane sheet is welded on each side of the membrane panel. Treatment water filtrated by the membrane cartridge goes through a tube and is drained by the manifold. A diffuser is installed under the membrane cartridge to prevent the membrane from clogging. Backflow of air and water from the diffuser cleans the surface of the membrane cartridge. Also, a permeate pump is not necessary in case there is more than 1.5 m water level difference between the reactor and the treated water tank.

Because the packing density in a cartridge is lower than that of a hollow fiber membrane, residue hardly gets tangled. In addition, membrane sheets do not come in contact with each other; therefore, durability tends to be high.

The chemical cleaning frequency is about once in every three to six months, and the chemical cleaning tank is not required since chemical cleaning can be done in the membrane tank.

From the points mentioned above, the general advantage of flat sheet membranes is easy O&M.



Source: Supplier Catalogue

Figure A6.2.1 Flat Sheet Membrane Unit

b) Hollow Fiber Membrane

Filtered water goes inside the hollow fiber membrane via the permeate pump as shown in the following figure. The sludge and residue adhered on the membrane surface are removed by back flow washing.

One of the defining characteristics of the hollow fiber membrane is its large membrane area. Its membrane module can be smaller than that of the flat sheet membrane, so the reactor can be more compact. In other words, the treatment capacity per installation area is larger.

From the viewpoint of the next renewal construction in the future, the compact structure of the hollow fiber membrane is an advantage.

Moreover, the MBR method requires a lot of energy compared with other wastewater treatment methods because electrical equipment, such as the diffuser installed under the membrane cartridge, is indispensable. The diffuser is minimized since the membrane cartridge is small, which means that the initial cost for facilities is lower.

Source: Supplier Catalogue

Figure A6.2.2 Hollow Fiber Membrane Unit

Taking into account the features mentioned above, the comparative study shown in Table 6.3.3 was conducted.

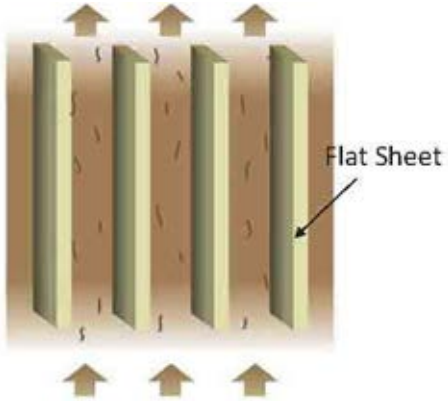
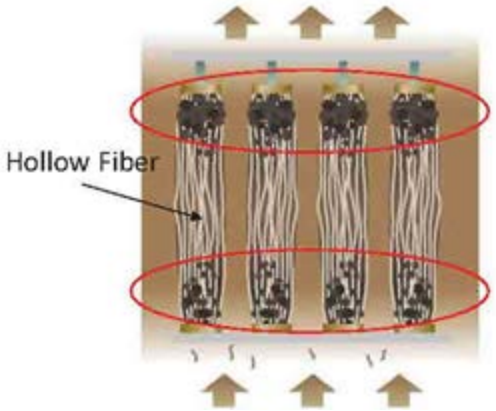
The general technology items have both advantages and disadvantages, so there is no remarkable difference.

However, generally, the footprint of the facility of Type 2 is smaller than Type 1. The space for the WWTP is limited in Magsaysay Park; therefore, the further study for the facility layout shall be based on Type 2, Hollow Fiber Membrane, in this survey.

On the other hand, the O&M cost for MBR is generally higher than the other treatment processes. The main reasons are the higher cost for energy (electricity) for operation and regular replacement of membrane modules. However, thanks to the technological advances, the regular replacement of membranes is about once every 10 years, and the cost gap become smaller than the one before.

In addition, because the operation is easier than the other treatment process such as CAS, adopting of MBR process in developing countries is increasing. (ie. Indonesia, Myanmar, etc.)

Table 6.3.1 Feature of Membrane Type and Comparative Study on Adaptability for the Project

	Type 1 Flat Sheet Membrane Type	Type 2 Hollow Fiber Membrane
General Layout		
Necessary Space	Larger than Type 2 (generally, 1.1 times compared with Type 2)	Smaller than Type 1
Initial Cost	Equivalent	Equivalent
Estimated Life	10 + years	5 – 7 years
Energy	0.4~0.6 kWh/m^3	0.4~0.6 kWh/m^3
Durability	Equivalent	Equivalent
MLSS	8,000 – 18,000 mg/L	1,000 – 8,000 mg/L
Transmembrane Pressure (TMP)	1 - 3 psi	7 – 10 psi
Backwash	Applicable	Not applicable
		Recommended

Source: JICA Survey Team

1. Name of Plant: Magsaysay Park WWTP

2. Design Parameters

2.1 Application

- Application: Municipal - Sewage

- Treatment process: MBR for BOD and N removal (Separated)

2.2 Capacity

Description	Unit	Value
Average daily flow	m^3/d	78000
Max monthly flow	m^3/d	
Max weekly flow	m^3/d	
Max daily flow	m^3/d	97000
Max hourly flow	m^3/h	

2.3 Water quality

Item	Unit	Inlet	Outlet	Removal Rate (%)
BOD	mg/L	200	30	85.0%
COD(Cr)*	mg/L		60	-
TSS	mg/L	200	70	65.0%
T-N**	mg/L	40	20	50.0%
T-P	mg/L	5	1	80.0%
Oil & Grease***	mg/L			-
Aveage Water Temp.	deg. C			
Max. Water Temp.****	deg. C			
Min. Water Temp.	deg. C	25		

Note:

* COD removal rate may be changed depending on COD composition.

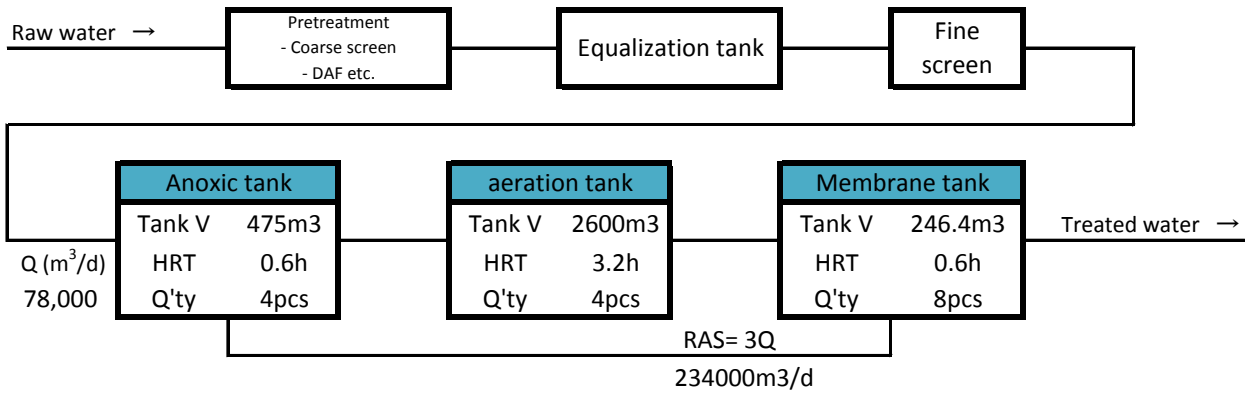
** If T-N removal rate is more than 80%, other T-N removal process may need to be designed OEM.

*** If O&G are exceeded(animal and vegetable oil : 150mg/L, mineral oil : not allowed), pre-treatment prior to MBR should be done by OEM.

**** If aeration tank temperature exceed 40 deg. C, biological processing performance declines.

3. Summary of MBR system / Membrane separation system

3.1 Process flow



Scope of proposal : Anoxic tank, aeration tank and Membrane tank
(Pretreatment processes are out of scope)

3.2 Volume and dimension of tank

Tank	Length (m)	Width (m)	Water depth (m)	tank V (m^3)	Q'ty (pcs)	Total tank V (m^3)
Anoxic tank	10.0	9.5	5.0	475.0	4	1900.0
aeration tank	10.0	52.0	5.0	2600.0	4	10400.0
Membrane tank	15.4	4.0	4.0	246.4	8	1971.2

Note

If you need brief layout of this system, please let us know.

3.3 Selected membrane module specification

- Product code 56M2400FF
- Membrane surface area 2400 m^2
- Size
  - Depth 1524 mm
  - Width 3416 mm
  - Height 2798 mm
- Weight (dry) 1550 kg
- Weight (lifting) 2100～5100 kg

3.4 Major equipment and instrument list for MBR system

No.	Equipment	Duty	Required specification
1	Anoxic tank mixer	4	-
2	aeration tank blower	4	65.3Nm3/min
3	aeration tank diffuser	4	-
4	Membrane module	56	56M2400FF
5	permeate pump	16	4.81m3/min
6	membrane tank blower	16	31.5Nm3/min
7	RAS pump	8	20.31m3/min
8	dilution water tank	1	101m3
9	dilution water pump	1	1120L/min
10	CIP pump (M.C.)	1	3.9L/min
11	CIP pump (R.C.)	1	23.5L/min
12	CIP pump (acid)	1	18L/min
13	NaClO tank	1	2117.6L
14	Acid tank	1	1079.5L

No.	Instrument	Duty	Note
1	Flow meter for permeate	8	For each membrane tank
2	Flow meter for RAS	8	For each train
3	Flow meter for aeration air	4	For each tank
4	Flow meter for membrane air	56	For each module
5	Level sensor for anoxic tank	4	For each tank
6	Level sensor for aeration tank	4	For each tank
7	Level sensor for membrane tank	8	For each tank
8	Pressure gage for permeate	56	For each module
9	DO sensor	4	For each aeration tank
10	pH sensor	4	For each aeration tank

Note

Stand-by equipments and instruments are not included in this proposal.
Safty factor is not included for required specifications.
Please select equipments and instruments by OEM in reference to this proposal.
Please design appropriate pre-treatment process (e.g. screen, DAF, etc.) by OEM.

3.5 Chemical Consumptiontem

Chemical	Consumption			
NaClO (12%)	2118	L/3months	8471	L/year
Citric acid	-	kg/month	540	kg/year
PAC (10%)	129.40	m^3/month	1553	m^3/year

4. Design and calculation

4.1 Membrane separation system

1) Membrane module

- Product code		56M2400FF	
- Membrane surface area per module		2400	m^2
- Design average daily flow		78000	m^3/d
- Number of train		8	train
- Number of module per train		7	module/train
- Total number of module		56	module
- Membrane surface area per train		16800	m^2
- Total Membrane surface area		134400	m^2
- Design average daily flux		0.58	m/d
		24.2	LMH
- Design peak flux	Designed by Max daily flow	0.72	m/d
		30.1	LMH

2) Membrane tank

- Number of membrane tank	8	
- Number of module per tank	7	
- Tank size and volume		
Length (inside, per tank)	15.4	m
Width (inside, per tank)	4.0	m
effective water depth	4.0	m
Volume	246.4	m^3
- Total membrane tank volume	1971.2	m^3

3) Major equipment for membrane

a. Permeate pump

- Required total flow rate for peak flux	4041.7	m^3/hr
- Intermittent operation		
Filtration	7	min
Relaxation	1	min
- Number of duty per train	2	
- Total number of duty	16	
- Required flow rate per each	4.81	m^3/min

b. Membrane blower

- Required total air flow rate	504	Nm^3/min
- Number of duty per train	2	
- Total number of duty	16	

- Required air flow rate per each	31.5	Nm^3/min
- Preqired pump discharge pressure per each	50	kPa

4) Chemical cleaning system

a. Required chemical cleaning

CIP(M.C., Maintenance cleaning)

- NaClO concentration	500	mg/L
- Required chemical solution volume per membrane module (2L/m^2)	4800	L
- Total Number of cleand membrane module per each time (each train)	7	
- Required chemical solution volume per each time	33600	L
- Chemical solution injection time	30	min

CIP(R.C., Recovery cleaning)

- NaClO concentration	3000	mg/L
- Required chemical solution volume per membrane module	4800	L
- Total Number of cleand membrane module per each time (each train)	7	
- Required chemical solution volume per each time	33600	L
- Chemical solution injection time / leave time	30 / 90	min

CIP(acid, Recovery cleaning by citric acid)

- Citric acid concentration	1	wt%
- Required chemical solution volume per membrane module	4800	L
- Total Number of cleand membrane module per each time (each train)	7	
- Required chemical solution volume per each time	33600	L
- Chemical solution injection time / leave time	30 / 90	min

b. Major equipment for chemical cleaning

Dilution water pump

- Required dilution water tank volume (M.C. × 3 times)	100.8	m3
- Required flow rate	1120.0	L/min

CIP(M.C.) pump

- Reqired NaClO(12%) volume per each time	117.6	L
- Number of duty	1	
- Required flow rate	3.92	L/min

CIP(R.C.) pump

- Reqired NaClO(12%) volume per each time	705.9	L
- Number of duty	1	
- Required flow rate	23.5	L/min

CIP(acid) pump

- Reqired ctric acid(50wt%) volume per each time	539.8	L
- Number of duty	1	
- Required flow rate	18.0	L/min

NaClO tank

- Required NaClO(12%) volume for 3 months (M.C. × 12 times & R.C. × 1 time)	2117.6	L

- Number of duty	1	
Citric acid tank		
- Required citric acid(50wt%) volume for 2 times of CIP(acid)	1079.5	L
- Number of duty	1	
4.2 Biological treatment system		
1) Load		
- Design average daily flow	78000	m^3/d
- Inlet BOD concentration	200	mg/L
- Inlet BOD load	15600.0	kg-BOD/d
- Inlet T-N concentration	40	mg/L
- Inlet T-N load	3120.0	kg-N/d
- Mass of produced excess sludge(assume excess sludge yield rate : 50%)	6630.0	kg/d
- Volume of produced excess sludge(assume MLSS : 10,000mg/L)	663.0	m^3/d
2) Condition for process calculation		
- Design liquid temperature (min. temp.)	25	℃
- BOD removal rate in aeration tank	0.168	kg-BOD/kg-SS/d
- Nitrification rate (assume 0.08 kg-N/kg-VSS/d at 20℃)	0.112	kg-N/kg-VSS/d
- Denitrification rate (assume 0.10 kg-N/kg-VSS/d at 20℃)	0.140	kg-N/kg-VSS/d
- BOD consumption of dentrification	2	kg-BOD/kg-N
- MLVSS/MLSS	80	%
3) Membrane tank		
- Required total volume of tank	184.8	m^3
- Design volume of each tank	246.4	m^3
- Design total volume of tank	1971.2	m^3
- Hydraulic retention time (HRT)	0.6065231	h
- Design MLSS concentration	10,000	mg/L
- BOD removal rate per unit volume	1.35	kg-BOD/m^3/d
- BOD removal capacity in membrane tank	2655.3	kg-BOD/d
- Nitrification rate per unit volume	0.90	kg-N/m^3/d
-Nitrification capacity in membrane tank	1769.4	kg-N/d
4) Anoxic tank		
- Required total volume of tank	1853.8	m^3
- Number of train per each anoxic tank	2	
- Total number of anoxic tank	4	
- Tank size and volume		
Length (inside, per tank)	10.0	m
Width (inside, per tank)	9.5	m
effective water depth	5.0	m
Design volume	475.0	m^3
- Total design anoxic tank volume	1900.0	m^3
- Design MLSS concentration	7,500	mg/L
- Denitrification rate per unit volume	0.84	kg-N/m^3/d
-Denitrification capacity in anoxic tank	1598.9	kg-N/d
- BOD removal rate per unit volume	3197.82	kg-BOD/m^3/d
- BOD removal capacity in anoxic tank	6075854.1	kg-BOD/d

5) aeration tank

- Required total volume of tank	10250.5	m^3
- Number of train per each aeration tank	2	
- Total number of aeration tank	4	
- Tank size and volume		
Length (inside, per tank)	10.0	m
Width (inside, per tank)	52.0	m
effective water depth	5.0	m
Design volume	2600.0	m^3
- Total design aeration tank volume	10400.0	m^3
- Design MLSS concentration	7,500	mg/L
- BOD removal rate per unit volume	1.26	kg-BOD/m^3/d
- BOD removal capacity in aeration tank	13133.5	kg-BOD/d
- Nitrification rate per unit volume	0.67	kg-N/m^3/d
-Nitrification capacity in aeration tank	7001.5	kg-N/d

6) RAS pump

- Required recirculation activated sludge flow	1.0	Q
- Design recirculation activated sludge flow	3.0	Q
- Number of duty per train	1	
- Total number of duty	8	
- Required flow rate per each	20.3	m^3/min

4.3 Oxygen supply system

1) Required oxygen

a. BOD removal

- BOD removal in aeration tank and membrane tank	15600.0	kg-BOD/d
- Oxygen consumption rate of BOD removal	0.6	kg-O_2/kg-BOD
- Required oxygen for BOD removal	6870.2	kg-O_2/d

b. Nitrification

- Nitrification in aeration tank and membrane tank	3120.0	kg-N/d
- Oxygen consumption rate of nitrification	4.57	kg-O_2/kg-N
- Required oxygen for nitrification	4134.9	kg-O_2/d

c. Endogenous respiration

- Amount of MLSS in aeration tank	7,500	mg/L
- Amount of MLSS in membrane tank	10,000	mg/L
- MLVSS/MLSS	0.8	
- Oxygen consumption rate of endogenous respiraiton	0.06	kg-O2/kg-MLSS/d
- Required oxygen for endogenous respiraiton	4690.2	kg-O_2/d

d. Maintain DO

- Design average daily flow	78000	m^3/d
- Recirculation flow rate (RAS)	234000	m^3/d
- Minimum residual DO	2	mg/L
- Required oxygen for maintain DO	624.0	kg-O_2/d

e. Total oxygen for biological treatment	16319.4	kg-O_2/d
2) Oxygen supplied by membrane module		
- Required air flow rate per each	9	Nm^3/min
- Number of module	56	
- Required total air flow rate	504	Nm^3/min
- Oxygen content of air	0.28	kg-O_2/m^3-air
- Oxygen transfer efficiency	6.0	%
- Oxygen supplied by membrane module	12062.1	kg-O_2/d
3) Reqired air flow of aeration tank		
- Reqired oxygen supply by aeration tank diffuser	13027.156	kg-O_2/d
- Oxygen transfer efficiency	12.5	%
- Reqired air flow for aeration tank diffuser	261.3	Nm^3/min
4) aeration tank blower		
- Reqired total air flow rate	261.3	Nm^3/min
- Total number of duty	4	
- Reqired total air flow rate for each aeration tank blower	65.3	Nm^3/min
4.4 T-P removal		
- Coagulant	PAC	
- Dosing condition	Dosing Al 1mol per P 1mol	
- Specific gravity of PAC (10% solution)	1.19	
- Required volume of PAC (10% solution)	4313.4	L/d

APPENDIX 6.3_PROPOSED SLUDGE TREATMENT FACILITIES

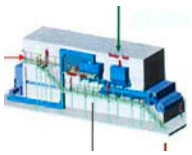
1) Type of Mechanical Sludge Drying Machine

There are three main types of dryers, which are listed as follows:

1. Disc Dryer Type
2. Hot Air Dryer Type
3. Band Dryer Type

The comparative table which indicates the characteristics is shown in following table.

Table A6.3.1 Comparison of Mechanical Sludge Drying Machine

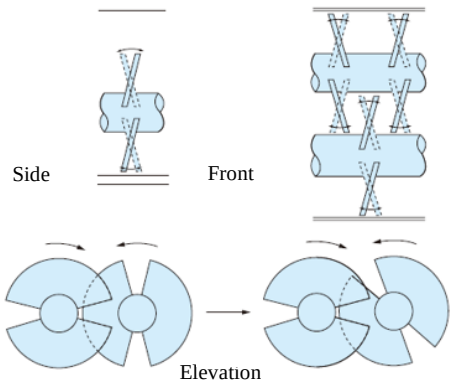
Item	Disc Dryer				Hot Air Dryer		Band Dryer	
	Inclined		Normal					
Image								
Heat Source	Steam		Steam		Hot Air (700~800 ^{0}C)		Hot Air (150 ^{0}C)	
Suitable WWTP Scale	Large	1	Large	1	Small	0	Small	0
Stability	Easy/Good	2	Unstable	0	Easy/Good	2	Complex/Good	1
Initial Cost	Middle	1	Low	2	Low	2	Middle	1
O&M Cost	Middle	1	Middle	1	High	0	Middle	1
Total Score	**Selected**	5	-	4	-	4	-	3

Source: JICA Survey Team

As a result of the study, the inclined paddle disc dryer type is selected for the project.

Details of the inclined disc dryer are described in Table A6.3.2.

Table A6.3.2 Feature of Inclined Disc Dryer

	Description
Image	 Source: Supplier Catalogue
Feature	• The machine supplies steam into shafts and discs which makes them warmer. Then, sludge is dried by indirectly conveying steam. • Exhaust gas can be reintroduced into the dryer facility after dehumidification. It leads even a smaller amount of exhaust gas which has to be deodorized in other ways. • By rotating the inclined discs, sludge attached on the discs can be easily removed. It leads to higher drying performance than a normal disc dryer.
Structure	 Source: Supplier Catalogue • The dryer facility has some discs extended respectively along one shaft center at some angle. • One facility has two or four shafts. • A dryer facility may have some discs extended along one shaft center at some angle. • One facility has two or four shafts.

Source: JICA Survey Team

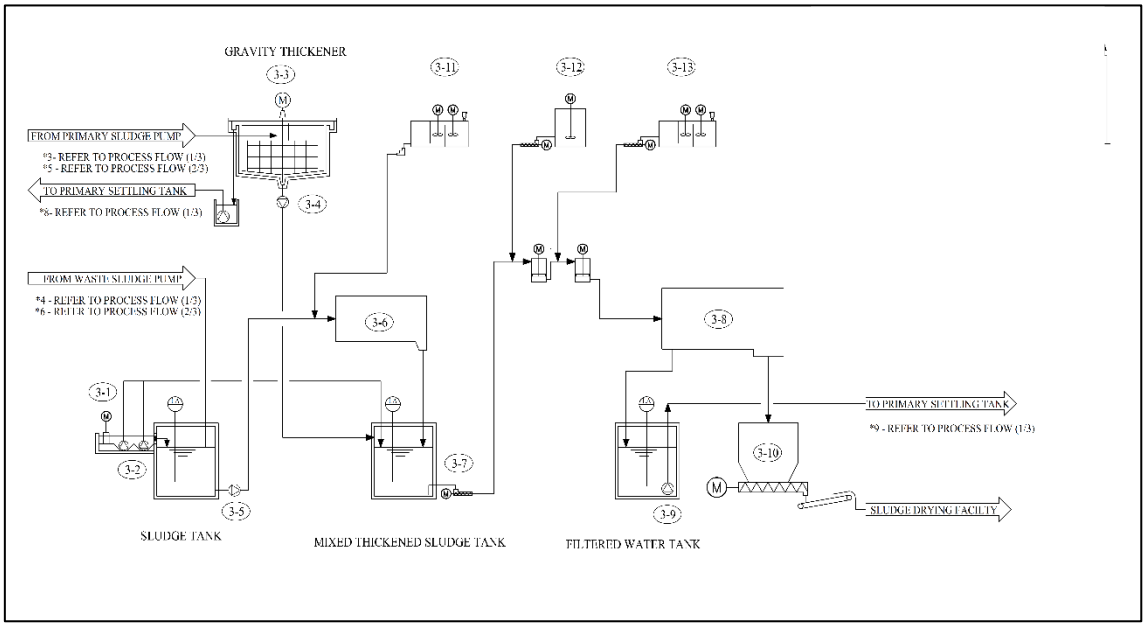
A sample of a mechanical dryer of the recommended inclined paddle disc type is shown in Figure A6.3.1 for reference.

Source: Supplier Catalogue

Figure A6.3.1 Mechanical Drying Machine for Reference

2) Process Flow Diagram of STFs

The process flow diagram of the STF is shown in Figure A6.3.2.

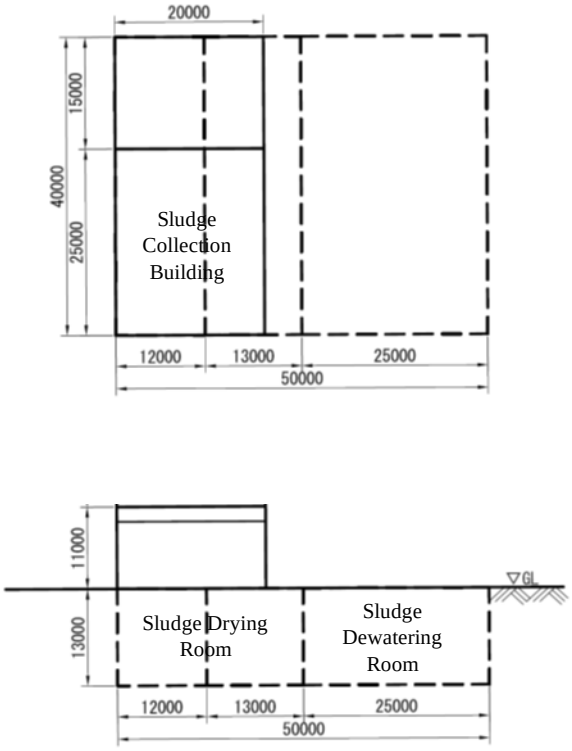


Source: JICA Survey Team

Figure A6.3.2 Process Flow Diagram of Sludge Treatment Facilities

3) General Layout of STFs

In accordance with the study results, the general plan of STFs, which includes a mechanical dryer of the inclined paddle disc type, is planned as shown in Figure A6.3.3.



Source: JICA Survey Team

Figure A6.3.3 General Plan of Sludge Treatment Facilities

4) Necessity of Disposal Facility for the Future

Davao city envisages that they would, as much as possible, utilize sludge generated from WWTP enhanced by the project instead of simply disposing it as solid waste. While the JICA Survey Team respects their idea, it may not be possible to utilize all of the sludge from the facility. The amount of dried sludge generated from WWTP is preliminarily estimated at about 30 m^3/day in its full operation years.

Therefore, it is necessary to find and secure such facility to prepare for future sludge generation.

Appendix 6.4 Flow Calculation Sheet and Longitudinal Profile of Trunk Sewers for Area-A

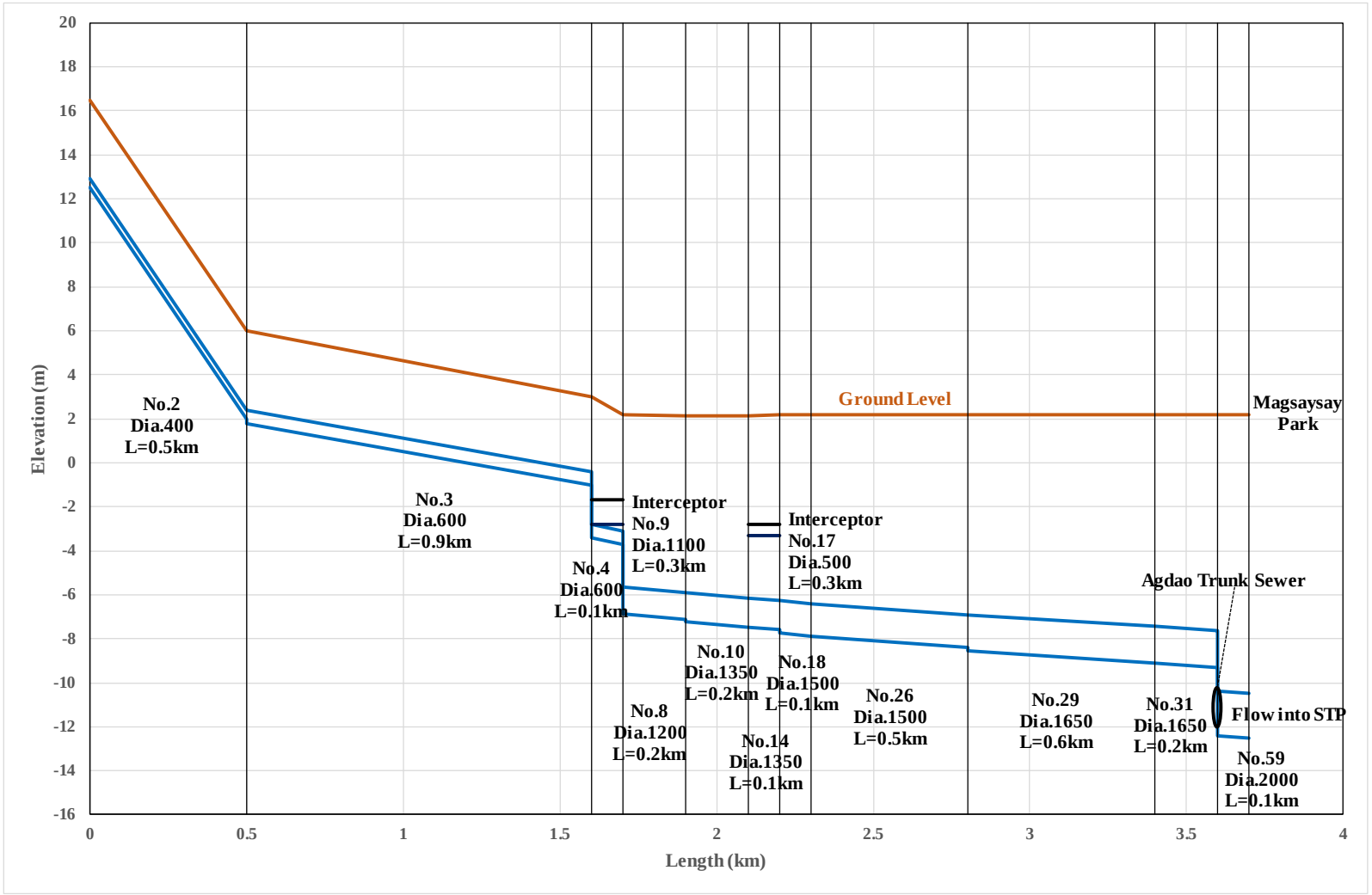
(1) Flow Calculation

Table 1: Flow Calculation

Sewer No.	Barangay	Downstream Sewer No.	Hourly Maximum Sewage Flow (m3/s)	Accumulated Sewage Flow (m3/s)	Diameter (mm)		Slope (%)	v (m/s)	Q_f (m3/s)	Length (km)	GL (m)		Elevation of bottom of pipe (m)		Depth of Excavation (m)	
					Minimum	Apply					Up	Down	Up	Down	Up	Down
1	40-D	4	0.016	0.016	180	400	0.364	1.000	0.126	0.8	4.0	3.0	0.0	-3.2	4.0	6.2
2	5-A		0.077	0.077	390	400	0.364	1.000	0.126	0.5	16.5	6.0	12.5	2.0	4.0	4.0
3	2-A		0.024													
	1-A		0.021	0.122	490	600	0.212	1.000	0.283	1.1	6.0	3.0	1.8	-1.0	4.2	4.0
4	39-D	8	0.035	0.173	580	600	0.212	1.000	0.283	0.1	3.0	2.2	-3.4	-3.7	6.4	5.9
5	6-A		0.014	0.014	170	200	0.917	1.000	0.031	0.5	16.5	6.0	12.5	2.0	4.0	4.0
6	3-A		0.003	0.017	190	200	0.917	1.000	0.031	0.6	6.0	3.5	2.0	-3.7	4.0	7.2
7	38-D		0.010	0.027	230	250	0.681	1.000	0.049	0.3	3.5	2.2	-3.8	-5.9	7.3	8.1
8		10		0.766	1,210	1200	0.084	0.999	1.130	0.2	2.2	2.1	-6.9	-7.1	9.1	9.2
9	Bucana		0.566	0.566	1,040	1100	0.095	1.003	0.953	0.3	1.6	2.2	-2.4	-2.8	4.0	5.0
10		14		1.332	1,600	1350	0.072	1.001	1.432	0.2	2.1	2.1	-7.3	-7.5	9.4	9.6
11	4-A		0.011	0.011	150	400	0.364	1.000	0.126	0.7	4.1	3.2	0.1	-2.7	4.0	5.9
12	35-D		0.004	0.015	170	400	0.364	1.000	0.126	0.3	3.2	2.8	-2.7	-3.9	5.9	6.7
13	36-D		0.011	0.026	230	400	0.364	1.000	0.126	0.3	2.8	2.2	-3.9	-5.1	6.7	7.3
14		18		1.358	1,620	1350	0.072	1.001	1.432	0.1	2.1	2.2	-7.5	-7.6	9.6	9.8
15	34-D		0.011	0.011	150	400	0.364	1.000	0.126	0.6	3.3	2.8	-0.7	-3.1	4.0	5.9
16	33-D	18	0.014	0.025	220	400	0.364	1.000	0.126	0.6	2.8	2.2	-3.1	-5.5	5.9	7.7
17	37-D		0.045	0.045												
	31-D		0.056	0.101	440	500	0.270	0.999	0.196	0.3	1.6	2.2	-2.4	-3.3	4.0	5.5
18		26		1.484	1,690	1500	0.062	0.996	1.760	0.1	2.2	2.2	-7.8	-7.9	10.0	10.1
19	7-A	22	0.027	0.027	230	400	0.200	0.741	0.093	0.5	4.1	3.5	0.1	-1.1	4.0	4.6
20	9-A	22	0.038	0.038	270	400	0.270	0.861	0.108	0.8	3.9	3.5	-0.1	-2.6	4.0	6.1
21	10-A		0.046	0.046	300	400	0.270	0.861	0.108	1	4.1	3.5	0.1	-3.0	4.0	6.5
22		24		0.111	470	500	0.270	0.999	0.196	0.2	3.5	3.3	-3.1	-3.7	6.6	7.0
23	11-B		0.013	0.013	160	400	0.260	0.845	0.106	1	4.2	3.3	0.2	-2.8	4.0	6.1
24	29-C		0.011	0.135	510	600	0.212	1.000	0.283	0.7	3.3	2.6	-3.8	-5.6	7.1	8.2
25	24-C		0.018	0.153	550	600	0.212	1.000	0.283	0.6	2.6	2.2	-5.6	-7.1	8.2	9.3
26	25-C	29	0.013	1.65	1,780	1500	0.062	0.996	1.760	0.5	2.2	2.2	-7.9	-8.4	10.1	10.6
27	28-C	29	0.015	0.015	170	400	0.200	0.741	0.093	0.5	2.6	2.2	-1.4	-2.6	4.0	4.8
28	21-C		0.05													
	22-C		0.045													
	23-C		0.111	0.206	630	700	0.173	1.001	0.385	0.5	1.6	2.2	-2.4	-3.5	4.0	5.7
29	26-C	31	0.017	1.888	1,900	1650	0.055	1.000	2.138	0.6	2.2	2.2	-8.6	-9.1	10.8	11.3
30	30-C		0.011	0.011	150	400	0.364	1.000	0.126	1.4	3.0	2.2	-1.0	-6.7	4.0	8.9
31		59		1.899	1,910	1650	0.055	1.000	2.138	0.2	2.2	2.2	-9.1	-9.3	11.3	11.5
32	27-C	59	0.015	0.015	170	400	0.364	1.000	0.126	1.4	3.2	2.2	-0.8	-6.5	4.0	8.7

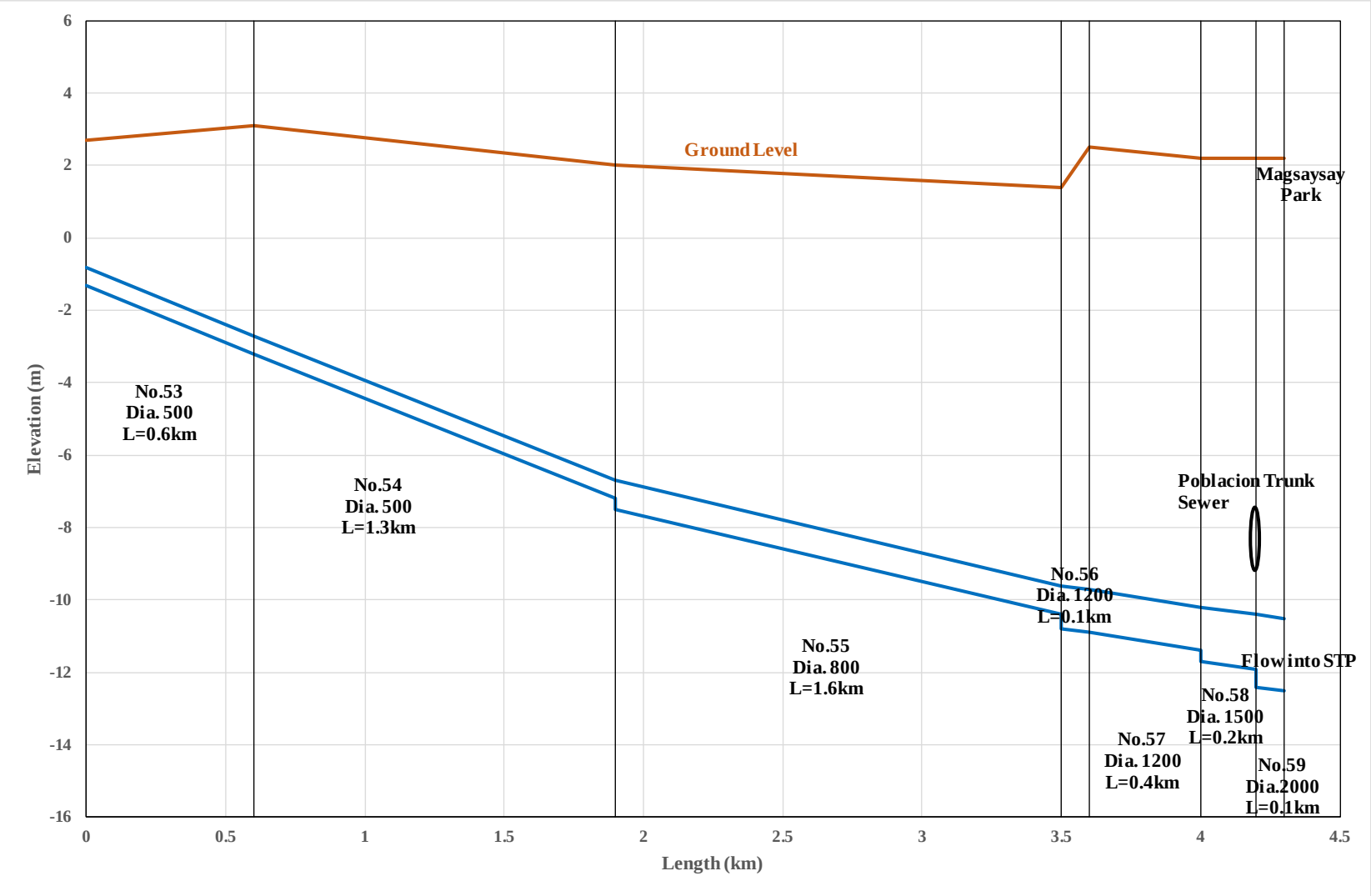
Sewer No.	Barangay	Downstream Sewer No.	Hourly Maximum Sewage Flow (m3/s)	Accumulated Sewage Flow (m3/s)	Diameter (mm)		Slope (%)	v (m/s)	Q_f (m3/s)	Length (km)	GL (m)		Elevation of bottom of pipe (m)		Depth of Excavation (m)	
					Minimum	Apply					Up	Down	Up	Down	Up	Down
33	19-B	35	0.214	0.214	640	700	0.173	1.001	0.385	2.3	30.0	5.0	26.0	1.0	4.0	4.0
34	20-B		0.031	0.031	250	400	0.364	1.000	0.126	1	8.0	5.0	4.0	0.0	4.0	5.0
35				0.245	690	700	0.173	1.001	0.385	0.8	5.0	3.5	-0.3	-2.0	5.3	5.5
36	12-B		0.006	0.251	700	800	0.144	0.998	0.502	0.6	3.5	2.8	-2.1	-3.2	5.6	6.0
37		40		0.251	700	800	0.144	0.998	0.502	0.6	2.8	2.4	-3.2	-4.3	6.0	6.7
38	13-B		0.005	0.005	100	400	0.200	0.741	0.093	0.1	3.5	2.5	-0.5	-0.7	4.0	3.2
39	14-B		0.008	0.013	160	400	0.200	0.741	0.093	1.2	2.5	2.4	-0.7	-3.6	3.2	6.0
40	Kept. Tomas	58	0.039	0.303	770	800	0.144	0.998	0.502	0.7	2.4	2.2	-4.3	-5.6	6.7	7.8
41	18-B		0.012	0.012	160	400	0.300	0.908	0.114	0.6	3.9	2.4	-0.1	-2.1	4.0	4.5
42		44		0.012	160	400	0.200	0.741	0.093	0.3	2.4	1.6	-2.1	-2.8	4.5	4.4
43	17-B		0.005	0.005	100	400	0.200	0.741	0.093	0.6	2.5	1.6	-1.5	-2.9	4.0	4.5
44		47		0.017	190	400	0.200	0.741	0.093	0.9	1.6	1.8	-2.9	-5.1	4.5	6.9
45	16-B		0.006													
	15-B		0.020	0.026	230	400	0.230	0.795	0.100	0.8	2.1	1.6	-1.9	-4.1	4.0	5.7
46				0.026	230	400	0.230	0.795	0.100	0.3	1.6	1.8	-4.1	-4.9	5.7	6.7
47		57		0.043	290	400	0.200	0.741	0.093	0.2	1.8	2.5	-5.1	-5.6	6.9	8.1
48	Gov. Paciano	56	0.061	0.061	350	400	0.364	1.000	0.126	1.7	4.0	1.4	0.0	-6.9	4.0	8.3
49	Wilfred Aquino	51	0.068	0.068	370	400	0.630	1.315	0.165	1.2	10.0	3.2	6.0	-2.0	4.0	5.2
50	San Antonio		0.071	0.071	370	400	0.364	1.000	0.126	1.6	7.2	3.2	3.2	-3.3	4.0	6.5
51	Agdao Proper	56	0.061	0.200	620	700	0.173	1.001	0.385	0.4	3.2	1.4	-3.6	-4.5	6.8	5.9
52	Ubalde	55	0.020	0.020	200	400	0.364	1.000	0.126	1	2.1	2.0	-1.9	-5.9	4.0	7.9
53	Lapu Lapu		0.081	0.081	400	500	0.270	0.999	0.196	0.6	2.7	3.1	-1.3	-3.2	4.0	6.3
54	Rafael Castillo	55	0.040	0.121	490	500	0.270	0.999	0.196	1.3	3.1	2.0	-3.2	-7.2	6.3	9.2
55	Centro San Juan		0.107													
	Gov. Vicente Duterte		0.061	0.309	770	800	0.144	0.998	0.502	1.6	2.0	1.4	-7.5	-10.4	9.5	11.8
56				0.570	1,050	1200	0.084	0.999	1.130	0.1	1.4	2.5	-10.8	-10.9	12.2	13.4
57	Leon Garcia		0.094	0.707	1,170	1200	0.084	0.999	1.130	0.4	2.5	2.2	-10.9	-11.4	13.4	13.6
58		59		1.010	1,390	1500	0.062	0.996	1.760	0.2	2.2	2.2	-11.7	-11.9	13.9	14.1
59				2.924	2,370	2000	0.043	1.005	3.157	0.1	2.2	2.2	-12.4	-12.5	14.6	14.7
To WWTP																

Source: JICA Survey Team



Source: JICA Survey Team

Figure-1: Poblacion Trunk Sewer



Source: JICA Survey Team

Figure-2: Agdao Trunk Sewer

Appendix 6.5 Assumed Lengths of Lateral Sewers in Baragangays in Area A

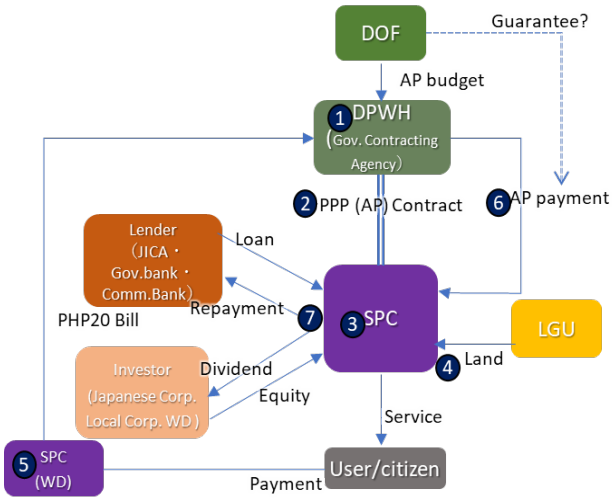
Barangay	Assumed Length (m)							
	Diameter (mm) - Open cut							Total
Poblacion District	200	250	300	350	400	450	500	
1-A	668	167	0	0	0	0	0	835
2-A	1,655	414	0	0	0	0	0	2,069
3-A	3,266	0	0	0	0	0	0	3,266
4-A	2,226	0	0	0	0	0	0	2,226
5-A	4,324	1,441	721	360	360	0	0	7,207
6-A	1,469	0	0	0	0	0	0	1,469
7-A	2,919	730	0	0	0	0	0	3,649
8-A	0	0	0	0	0	0	0	0
9-A	3,239	925	463	0	0	0	0	4,627
10-A	2,417	691	345	0	0	0	0	3,453
11-B	1,276	0	0	0	0	0	0	1,276
12-B	1,469	0	0	0	0	0	0	1,469
13-B	1,079	0	0	0	0	0	0	1,079
14-B	1,767	0	0	0	0	0	0	1,767
15-B	3,964	0	0	0	0	0	0	3,964
16-B	1,474	0	0	0	0	0	0	1,474
17-B	1,348	0	0	0	0	0	0	1,348
18-B	3,640	0	0	0	0	0	0	3,640
19-B	15,656	12,656	9,656	8,484	4,484	4,311	1,311	56,557
20-B	6,815	1,704	0	0	0	0	0	8,519
21-C	3,340	954	477	0	0	0	0	4,771
22-C	3,563	1,018	509	0	0	0	0	5,090
23-C	3,143	1,048	524	262	262	0	0	5,239
24-C	727	0	0	0	0	0	0	727
25-C	968	0	0	0	0	0	0	968
26-C	1,435	0	0	0	0	0	0	1,435
27-C	3,780	0	0	0	0	0	0	3,780
28-C	2,639	0	0	0	0	0	0	2,639
29-C	1,209	0	0	0	0	0	0	1,209
30-C	3,483	0	0	0	0	0	0	3,483
31-D	6,136	1,753	877	0	0	0	0	8,766
32-D	4,232	0	0	0	0	0	0	4,232
33-D	865	0	0	0	0	0	0	865
34-D	1,952	0	0	0	0	0	0	1,952
35-D	958	0	0	0	0	0	0	958
36-D	1,030	0	0	0	0	0	0	1,030
37-D	2,754	787	393	0	0	0	0	3,934
38-D	1,607	0	0	0	0	0	0	1,607
39-D	1,801	514	257	0	0	0	0	2,572
40-D	1,292	0	0	0	0	0	0	1,292
Bucana (East)	12,301	4,100	2,050	820	615	410	205	20,502
Total (Poblacion + Bucana)	119,889	28,902	16,272	9,926	5,721	4,721	1,516	186,948
Agdao District								
Kept. Tomas Monteverde	2,323	664	332	0	0	0	0	3,319
Gov. Paciano	8,310	2,770	1,385	1,385	0	0	0	13,850
Wilfred Aquino	7,371	2,457	1,228	614	614	0	0	12,285
San Antonio	9,167	3,056	1,528	764	764	0	0	15,279
Agdao Proper	3,905	1,302	651	651	0	0	0	6,509
Ubalde	1,697	0	0	0	0	0	0	1,697
Lapu Lapu	6,119	2,040	1,020	510	510	0	0	10,198
Rafael Castillo	5,300	1,514	757	0	0	0	0	7,571
Centro San Juan	4,435	1,478	739	370	370	0	0	7,392
Gov. Vicente Duterte	5,306	1,769	884	442	442	0	0	8,843
Leon Garcia	2,329	776	388	194	194	0	0	3,882
Total (Agdao)	56,262	17,825	8,913	4,930	2,894	0	0	90,823
Total Area A	**176,150**	**46,728**	**25,185**	**14,856**	**8,615**	**4,721**	**1,516**	**277,771**

Appendix 6.6 Study on Potential Financing Scheme as Public-Private-Partnership Project

JICA Survey Team conducted information hearings on possible PPP scheme. Since preliminary cashflow analysis indicated the project was commercially unviable, interviews focused on the possibility of Availability Payment (AP) Scheme.

Basic concept of availability payment is that private sector is entitled to receive predetermined payment (maximum AP) from government contracting agency (GCA) regardless of project demand. The maximum AP shall include debt service, operation cost and margin of private sector. Construction and operation is monitored by GCA and when performance of private sector does not meet the pre-agreed standard (e.g. environmental quality of effluent water), AP would be deducted.

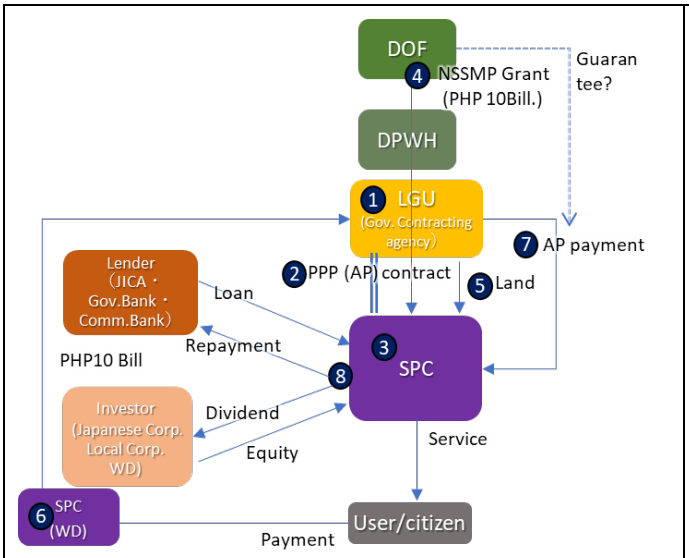
Scheme diagrams below are only draft images of PPP AP scheme with DPWH and LGU being Government Contracting Agency respectively.

Scheme Diagram	Key Description
	**【Construction period】** ① DPWH as government contracting agency ② PPP (Availability Payment) contract between DPWH and SPC ③ SPC designs, builds, finances the project facility ④ LGU provides land + permits **【Operation period】** ⑤ SPC (mainly WD) collects tariff and revenue will be transferred to DPWH. ⑥ DPWH provides availability payment to SPC based on SPC's performance ⑦ SPC repays to lender and provides dividend to investor

Source: JICA Survey Team

Figure 1.1 Proposed Image of Availability Payment Scheme (DPWH as GCA)

Scheme Diagram	Key Description



【Construction period】

① LGU as government contracting agency
② PPP (Availability Payment) contract between LGU and SPC
③ SPC designs, builds and finances the project facility
④ City provides 50% of CAPEX through NSSMP grant
⑤ City provides land + permits

【Operation period】

⑥ SPC (mainly WD) collects tariff and revenue will be transferred to LGU.
⑦ LGU provides availability payment to SPC based on SPC's performance
⑧ SPC repays to lender and provides dividend to investor

Source: JICA Survey Team

Figure 1.2 Proposed Image of Availability Payment Scheme (LGU as GCA)

Water Districts are entitled to become GCA (BOT law 2012), however in this survey the option was omitted due to ring-fencing regulation applied by LWUA. It was presumed that when DCWD is not allowed to cross-subsidize water revenue to wastewater, they will have difficulties finding source of availability payment. One option for DCWD is that they join SPC as an investor, participate in operation and utilize water tariff collection network to collect sewerage tariff (which shall be passed through to GCA).

Key information collected from interviews was as follows.

■ PPP Center

・DPWH legal department should state its position whether it can be the GCA of local sewerage project.

・In general, AP scheme is possible based on BOT law (2012) section 12:16.

・In general, it is possible for DPWH to secure AP budget backed by DBM Multi-Year Obligation letter (2016 DBM Circular).

・DPWH becoming GCA for this project and secure AP budget seems to take longer time: firstly the project needs to be included as priority, then DPWH will need to secure its AP budget which requires lot of convincing of relevant agencies (since sewerage sector is not DPWH's main mandate).

・LGU is eligible for becoming GCA for PPP (AP scheme). LGU should be able to commit to multi-year payment obligation.

■ DPWH

・Opinions on the possibility of becoming GCA for a local sewerage project varied within DPWH.

・NSSMP department commented it is difficult to use the NSSMP grant to a PPP project (no matter what agency becomes GCA), until guideline is finalized and approved.

■ Metro Pacific Water and Maynilad

・Metro Pacific Water has invested in water and wastewater joint project, but never wastewater alone project due to lack of commercial viability.

・For Metro Manila Water and Wastewater project (not under regulation of LWUA), shortage of sewerage tariff revenue to full cost recovery is covered by water revenue.

- LWUA

・When water districts are involved in anyway for a PPP project, LWUA guideline will be applied including affordability standard for tariff setting and ring-fencing.

- LGU

・LGU has not become the GCA of a PPP project.

・LGU applies single year budget system. LGU is eligible to commit multi-year budget for a project but has no precedent case.

Appendix 6.7 Forestry Related DENR Policies

GOVPH (HTTP://WWW.GOV.PH) MAIN MENU

(/)

FORESTRY RELATED DENR POLICIES

AUXILIARY MENU

Programs and Projects (/index.php)

YOU ARE HERE: / HOME (/INDEX.PHP) / LAWS AND POLICIES

P.D. 705 (/PDF/PD705.PDF)

Revising Presidential Decree No. 389, Otherwise Known As The Forestry Reform Code Of The Philippines

E.O. 192, S. 1987 (/PDF/EO192S.1987.PDF)

Providing For The Reorganization Of The Department Of Environment, Energy And Natural Resources; Renaming It As The Department Of Environment And Natural Resources And For Other Purposes

2019

DENR ADMINISTRATIVE ORDER

- **DAO 2019-03 (https://drive.google.com/open?id=1oBtK_OFOCD2GTIvnj8nR3YWqqC8EBf40)**
  Revised Implementing Rules and Regulations of Executive Order No. 193, Series of 2015: Expanding and Enhancing the Coverage of the National Greening Program

2018

DENR ADMINISTRATIVE ORDER

- **DAO 2018-21 (https://drive.google.com/open?id=1pfu5FC5-kVg9DtVcPFFVB9Uf3OgOUekJ)**
  Adoption of the Lawin Forest and Biodiversity Protection System as a National Strategy for Forest and Biodiversity Protection in the Philippines
- **DAO 2018-16 (https://drive.google.com/open?id=1Ag-3NgYL8HiCokZFM85RerrVYDPZvYSd)**
  Guidelines in the Processing and Issuance of Permits on the Removal and Relocation of Trees Affected by DPWH Projects
- **DAO 2018-09 (https://drive.google.com/open?id=1l_GjF7N5DHwCqRPc1Qsr_J9hpqPovaw4)**
  Amending Section 3 of DENR Administrative Order No. 2003 - 24 Implementing Republic Act No. 9175 Otherwise Known as Chainsaw Act of 2002
- **DAO 2018-08 (https://drive.google.com/open?id=1RVV8S-hFJpAwMHugyamHn7nN4lLv_U3l)**
  Guidelines for the Implementation of Republic Act No. 9772: "An Act Imposing a Logging Ban in the Province of Southern Leyte"

JOINT ADMINISTRATIVE ORDER

- **JAO 2018-01 (https://drive.google.com/open?id=1Oglq2ZcRYhSNpW3T-1cV0V2-NhhWL2N3)**
  Guidelines on the Registration of Land Conveyances Confiscated Pursuant to Section 77-A of Presidential Decree No.705, as Amended

2015 (/PDF/EO192S.1987.PDF)

EXECUTIVE ORDER

- **E.O. No. 193 (/pdf/policies/2015/eo-2015-193.pdf)**
  Expanding the Coverage of the National Greening Program

REPUBLIC ACT

- **R.A. No. 10690 (/pdf/policies/RA No. 10690.pdf)**
  An act regulating the practice of forestry in the Philippines and

appropriating funds therefor, repealing for the purpose republic act numbered six thousand two hundred thirty-nine (R.A. No. 6239), known as "The Forestry Profession Law"

2014 (/PDF/EO192S.1987.PDF)

JOINT MEMORANDUM CIRCULAR

- **JMC 2014-01 (/pdf/policies/2014/jmc/jmc-2014-01.pdf)**
  Guidelines for the Implementation of the DPWH-DENR-DSWD Partnership on the Tree Replacement Project

2013 (/PDF/EO192S.1987.PDF)

PROCLAMATION

- **Proclamation No. 2013-663 (/pdf/policies/2013/proc/Proclamation 663-2013.pdf)**
  Repealing Proclamation No. 2057 and Transferring the Administration of the Busuanga Pasture Reserve to the Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR)

DENR MEMORANDUM CIRCULAR

- **DMC 2013-06 (/images/policies/2013/dmc/dmc-2013-06.pdf)**
  Guidelines and Procedure for Plantation Development for the National Greening Program With Area Coverage of 100 Hectares and Above within Public Forestlands through the Engagement of Services of Private Sectors, Civil Society Organization, Non Government Organizations, People's Organizations/ Indigenous People, Local Government Units and Other Government Entities

JOINT MEMORANDUM CIRCULAR

- **JMC 2013-03 (/pdf/policies/2013/jmc/jointdenr-dilgmc-2013-03.pdf)**
  Guidelines in the Establishment and Implementation of Barangay Forest Program in Support of the National Greening Program

MEMORANDUM

- **MEMO 2013-515 (/pdf/policies/2013/memo/memo-2013-515.pdf)**
  Revised Procedures in the Submission of LGU Shares in the Proceeds from Collection of Forest Charges
- **MEMO 2013-265 (/images/policies/2013/memo/memo-2013-265.pdf)**
  Further Clarification on the Term LGU Endorsement for the Application for a Forest Land Grazing Management Agreement
- **MEMO 2013-118 (/images/policies/2013/memo/memo-2013-118.pdf)**
  Processing of Special Land-use Permits with Tree Cutting/Earth-Balling
- **MEMO 2013-74 (/images/policies/2013/memo/memo-2013-74.pdf)**
  Clarification on the Suspension on the Processing of All Request for Cutting Permits
- **MEMO 2013-28 (/images/policies/2013/memo/memo-2013-28.pdf)**
  Renewal and Cancellation of Certificate of Stewardship Contract (CSC)

2012 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 2012-05 (/images/policies/2012/dao/dao-2012-05.pdf)**
  Guidelines on Surveillance, Monitoring, Prevention, Control and Reporting of Forest Pests

DENR MEMORANDUM CIRCULAR

- **DMC 2012-01 (/images/policies/2012/dmc/dmc-2012-01.pdf)**
  Implementation of the National Greening Program

DENR MEMORANDUM ORDER

- **DMO 2012-02 (/images/policies/2012/dmo/dmo-2012-02.pdf)**
  Uniform Replacement Ratio for Cut or Relocated Trees

2011 (/PDF/EO192S.1987.PDF)

EXECUTIVE ORDER

- **Executive Order No.23 (/images/policies/2011/eo/executive_order_no._23_692.pdf)**
  Declaring a moratorium on the cutting and harvesting of timber in the natural and residual forests and creating the anti- illegal logging task force.
- **Executive Order No.26 (/pdf/policies/2011/executive_order_no._26.pdf)**
  Declaring an Interdepartmental Convergence Initiative for a National Greening Program

DENR MEMORANDUM ORDER

- **DMO 2011-02 (/images/policies/2011/dmo/dmo-2011-02.pdf)**
  Requiring submission of Tourism Development Plan (TDP) duly approved by the Department of Tourism (DOT) and comprehensive development and management plan for FLAgT applicants

MEMORANDUM

- **MEMO 2011-262_891 (/images/policies/2011/memo/memo-2011-262_891.pdf)**
  Processing and transport of timber cut/harvested from natural and residual forest prior to the issuance of E.O. 23
- **MEMO 2011-26_159 (/images/policies/2011/memo/memo-2011-26_159.pdf)**
  Suspending the Implementation of DENR Administrative Order No. 2004-04 (Guidelines on the Utilization and Transport of Planted Trees in Private Lands)
- **MEMO 2011-52_201 (/images/policies/2011/memo/memo-2011-52_201.pdf)**
  Instructions Relative to Executive Order No. 23 "Declaring a Moratorium on the Cutting and Harvesting of Timber in the Natural and Residual Forests and Creating the Anti-Illegal Logging Task Force."
- **MEMO 2011-113_705 (/images/policies/2011/memo/memo-2011-113_705.pdf)**

Instruction Relative to the Issuance of Transport Documents for All Timber Cut/Harvested from Natural and Residual Forests Including Lumber and Other Wood Products Processed Prior to Executive Order No. 23

2010 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 2010-11 (/images/policies/2010/dao/dao-2010-11.pdf)**
  Revised regulations governing forest tree seed and seedling production, collection and disposition
- **DAO 2010-08 (/images/policies/2010/dao/dao-2010-08.pdf)**
  Amending Further Section 19, Chapter VIII of DAO No. 2004-28 as Amended by DAO No. 2009-16 Dated 25 November 2009

DENR MEMORANDUM ORDER

- **DMO 2010-09 (/images/policies/2010/dmo/dmo-2010-09.pdf)**
  No Acceptance and Processing of Applications for Logging Contracts (IFMAs; SIFMAs; etc)
- **DMO 2010-05 (/images/policies/2010/dmo/dmo-2010-05.pdf)**
  Further Amending and Clarifying Certain Provisions of Memorandum Circular No. 2009-03 Entitled Supplemental Guidelines and Procedures in the Implementation of the Upland Development Program

2009 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 2009-16 (/images/policies/2009/dao/dao-2009-16.pdf)**
  Amending Certain Provisions of DENR Administrative Order No. 2004-28 Re: Rules and Regulations Governing the Use of Forestlands for Tourism Purposes (FLagT)

DENR MEMORANDUM FROM THE SECRETARY

- **MemoSec 09-OCT-2009 (/images/policies/2009/memosec/memo_459.pdf)**
  Re: Memorandum of Agreement (MOA) Dated 15 February 1996 Entered Into By and Between DENR, Represented by Secretary

Victor O. Ramos and the DOTC Represented by Jesus B. Garcia, Jr. on the Registration of Conveyances Seized, Confiscated and Forfeited in Favor of the Government.

DENR MEMORANDUM CIRCULAR

- **DMC 2009-09 (/images/policies/2009/dmc/dmc-2009-09.pdf)**
  Amendments/Addendum To DENR MC No. 2009-03 Entitled Supplemental Guidelines And Procedures In The Implementation Of The Upland Development Program (UDP)
- **DMC 2009-07 (/images/policies/2009/dmc/dmc-2009-07.pdf)**
  Guidelines and Procedures on the Role of the Research Sector in the Implementation of the Upland Development Program
- **DMC 2009-06 (/images/policies/2009/dmc/dmc-2009-06_311.pdf)**
  Administrative and Financial Guidelines of the Upland Development Program
- **DMC 2009-05 (/images/policies/2009/dmc/dmc-2009-05_308.pdf)**
  Amendment of Memorandum Circular 2009-03 - "Supplemental Guidelines and Procedures in the Implementation of the Upland Development Program"
- **DMC 2009-04 (/images/policies/2009/dmc/dmc-2009-04_466.pdf)**
  Addendum to DENR Memorandum Circular 2009-03 Re: "Supplemental Guidelines and Procedures in the Implementation of the Upland Development Program"
- **DMC 2009-03 (/images/policies/2009/dmc/dmc-2009-03_683.pdf)**
  Supplemental Guidelines and Procedures in the Implementation of the Upland Development Program

2008 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 2008-26 (/images/policies/2008/dao-2008-26_114.pdf)**
  Revised implementing rules and regulations of Republic Act No. 7586 or the National Integrated Protected Areas Systems (NIPAS) Act of 1992.

- **DAO 2008-24 (/images/policies/2008/dao-2008-24_298.pdf)**
  Guidelines for the assessment and delineation of boundaries between forestlands, national parks and agricultural lands.

2007 (/PDF/EO192S.1987.PDF)

DENR MEMORANDUM FROM THE SECRETARY

- **MemoSec 26-OCT-2007 (/images/policies/2007/memosec/memosec-071026.pdf)**
  Strict observance and implementation of procedures and guidelines in the inventory of timber and rattan resources
- **MemoSec 30-JULY-2007 (/images/policies/2007/memosec/memosec-070730.pdf)**
  Defining the parameters in the delegation of authorities to the field offices in the processing and issuance of community-based forest management agreements and resource utilization permits
- **MemoSec 12-JULY-2007 (/images/policies/2007/memosec/memosec-070712.pdf)**
  Lifting the suspension of harvesting and transporting of planted trees/ timber cut in plantation forest covered by forestry tenure instruments
- **MemoSec 02-JULY-2007 (/images/policies/2007/memosec/memosec-070702.pdf)**
  Review all titled properties within protected areas and proclaimed watersheds
- **MemoSec 02-MAY-2007 (/images/policies/2007/memosec/memosec-012805.pdf)**
  Harvesting operations in timber license agreement (TLA) converted into integrated forest management agreement (IFMA) with utilized allowable cut.

DENR ADMINISTRATIVE ORDER

- **DAO 2007-33 (/images/policies/2007/dao/dao-2007-33_816.pdf)**
  Amending DAO 2006-13 by lifting the ban on the cutting and transport of planted species within private lands and the cutting and transport of non-timber forest products (NTFPs) in the province of Lanao del Norte

- **DAO 2007-31 (/images/policies/2007/dao/dao-2007-31_549.pdf)**
  Amending certain provisions of DAO 1994-07, and prescribing the use of computer generated Certificate of Timber Origin (CTO) and Certificate of Lumber Origin (CLO) forms
- **DAO 2007-13 (/images/policies/2007/dao/dao-2007-13_895.pdf)**
  Lifting of the moratorium on new Wood Processing Plants (WPP's)

DENR MEMORANDUM CIRCULAR

- **DMC 2007-09 (/images/policies/2007/dmc/DMC2007-09.pdf)**
  Clarifications on the implementation of DAO 2007-13: "Lifting of the moratorium on new Wood Processing Plants (WPP's)"

2006 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 2006-01 (/images/policies/2006/dao/dao2006-01.pdf)**
  Imposition of Total Ban on Logging, Tree Cutting and Transport of forest products in Lanao Del Norte.

DENR MEMORANDUM FROM THE SECRETARY

- **MemoSec 10-APR-2006 (/images/policies/2006/memosec/memosec-041006.pdf)**
  Strict observance and implementation of procedures and guidelines in the inventory of timber and rattan resources
- **MemoSec 13-MAR-2006 (/images/policies/2006/memosec/memosec-031306.pdf)**
  Defining the parameters in the delegation of authorities to the field offices in the processing and issuance of community-based forest management agreements and resource utilization permits

DENR MEMORANDUM CIRCULAR

- **DMC 2006-01 (/images/policies/2006/dmc/dmc-2006-01.pdf)**
  Non-Tilting of Lands and Areas Suitable for fishery Purposes/ Operations even within Alienable and Disposable (A & D) Lands

2005 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 25-2005 (/images/policies/2005/dao/DAO25-2005.pdf)**
  Guidelines in the Implementation of Upland Agro-forestry Program
- **DAO 23-2005 (/images/policies/2005/dao/DAO23-2005.pdf)**
  Adoption and Implementation of Collaborative Approach to Watershed Management

DENR MEMORANDUM ORDER

- **MO 19-2005 (/images/policies/2005/dmo/MO-19-2005.pdf)**
  Authorizing the Regional Executive Director of DENR Cordillera Administrative Region to Issue Cutting Permits Involving Thirty (30) Trees or Less.
- **MO 02-2005 (/images/policies/2005/dmo/MO-02-2005.pdf)**
  Special Recovery Authority for Stumps of Drifted Logs and Uprooted Trees in Quezon and Aurora
- **MO 01-2005 (/images/policies/2005/dmo/MO-01-2005.pdf)**
  Special Recovery Authority for Drifted Tops and Branches for Charcoal Making in Quezon and Aurora

DENR MEMORANDUM CIRCULAR

- **DMC 2005-05 (/images/policies/2005/dmc/dmc2005-005.pdf)**
  Adopting Forestry Definitions Concerning Forest Cover/Land Use)

2004 (/PDF/EO192S.1987.PDF)

PRESIDENTIAL PROCLAMATION

- **Proclamation No. 643 (/images/policies/2004/eo/proc643.pdf)**
  Amending Proclamation no. 396 dated June 2, 2003, entitled "Enjoining the active participation of all government agencies, including government-owned and controlled corporations, private sector, schools, civil society groups and the citizenry in tree planting activity and declaring June 25, 2003 as Philipines Arbor day"

DENR MEMORANDUM FROM THE SECRETARY

- **MemoSec 05-NOV-2004 (/images/policies/2004/memosec/memo-579.pdf)**
  Clarification on the Harvesting and Utilization of Non-timber Forest Products

DENR ADMINISTRATIVE ORDER

- **DAO 2004-59 (/images/policies/2004/dao/dao2004-59.pdf)**
  Rules and Regulations Governing the Special Uses of Forestlands
- **DAO 2004-52 (/images/policies/2004/dao/dao2004-52.pdf)**
  The Revised Guidelines in the Issuances of Cutting/Harvesting Permits in Private Titled Lands
- **DAO 2004-51 (/images/policies/2004/dao/dao2004-51.pdf)**
  Declaring a Portion of the Osmena Reforestation Project Located in Camp 7, Minglanilla, Cebu as Experimental Forest Station
  DAOs 37-50 series of 2004
  "Declaring Certain Portions of the Public Forest as Agricultural Land (A and D) for Cropland and Other Purposes and Setting Aside Certain Parcels Thereof for Permanent Forest Purposes Under:
- **DAO 2004-50 (/images/policies/2004/dao/dao2004-50.pdf)**
  LC Project No. 24-B, Municipality of Gabaldon, Nueva Ecija"
- **DAO 2004-49 (/images/policies/2004/dao/dao2004-49.pdf)**
  LC Project No. 17-B, Municipality of Calaca, Batangas"
- **DAO 2004-48 (/images/policies/2004/dao/dao2004-48.pdf)**
  LC Project Nos. 19-A of Lubao, 29 of Sasmuan, 18-A of Guagua, 22-A of Minalin, 20-A of Macabebe and 21-B of Masantol, Province of Pampanga"
- **DAO 2004-47 (/images/policies/2004/dao/dao2004-47.pdf)**
  LC Project No. 1-D Roxas City, Province of Capiz"
- **DAO 2004-46 (/images/policies/2004/dao/dao2004-46.pdf)**
  LC Project No. 35-D, Municipality of Marihatag, Province of Surigao del Sur"
- **DAO 2004-45 (/images/policies/2004/dao/dao2004-45.pdf)**
  LC Project No. 1-Z, Puerto Princesa City, Palawan"
- **DAO 2004-44 (/images/policies/2004/dao/dao2004-44.pdf)**
  LC Project No. 1-Z-A, Puerto Princesa City, Palawan"
- **DAO 2004-43 (/images/policies/2004/dao/dao2004-43.pdf)**
  LC Project No. 9-S, Municipality of Maramag, Bukidnon"

- **DAO 2004-42 (/images/policies/2004/dao/dao2004-42.pdf)**
  LC Project No. 16-C and 17-B, Municipalities of Orion and Limay, Bataan"
- **DAO 2004-41 (/images/policies/2004/dao/dao2004-41.pdf)**
  LC Project No. 7-B, Municipality of Ivisan, Capiz and LC Project No. 64-B, Municipality of Oslob, Cebu"
- **DAO 2004-40 (/images/policies/2004/dao/dao2004-40.pdf)**
  LC Project Nos. 7-D and 9-C, Municipalities of Aparri and Ballesteros, Cagayan"
- **DAO 2004-39 (/images/policies/2004/dao/dao2004-39.pdf)**
  LC Project No. 17-K, Municipality of Siocon, Zamboanga del Norte"
- **DAO 2004-38 (/images/policies/2004/dao/dao2004-38.pdf)**
  LC Project No. 5-G, Municipality of Itogon, Benguet"
- **DAO 2004-37 (/images/policies/2004/dao/dao2004-37.pdf)**
  LC Project Nos. 14-B, 19-F and 23-C Municipalities of Claveria, Pamplona and Sanchez Mira, respectively, Province of Cagayan"
- **DAO 2004-35 (/images/policies/2004/dao/dao2004-35.pdf)**
  Amending Certain Sections of DAO 1999-36 Entitled "Revised Rules and Regulations Governing the Administration, Management, Development, and Disposition of Forest Lands Used for Grazing Purposes
- **DAO 2004-34 (/images/policies/2004/dao/dao2004-34.pdf)**
  Guidelines in the Preparation, Submission, Review and Approval of a Multi-year Operations Plan (MYOP) for Timber License Agreement (TLA) Holders
- **DAO 2004-30 (/images/policies/2004/dao/dao2004-30.pdf)**
  Revised Rules and Regulations Governing the Socialized Industrial Forest Management Program
- **DAO 2004-29 (/images/policies/2004/dao/dao2004-29.pdf)**
  Revised Rules and Regulations for the Implementation of E.O. 263, Otherwise Known as the community-based Forest Management Strategy
- **DAO 2004-28 (/images/policies/2004/dao/dao2004-28.pdf)**
  Rules and Regulations Governing the Use of Forestlands for Tourism Purposes
- **DAO 2004-16 (/images/policies/2004/dao/DAO16-2004.pdf)**
  Prescribing the Revised Schedule of Forestry Administrative Fees

- **DAO 2004-04 (/images/policies/2004/dao/dao2004-04.pdf)**
  Guidelines on the Utilization and Transport of Planted Trees in Private Lands

DENR MEMORANDUM ORDER

- **DMO 2004-04 (/images/policies/2004/dmo/DMO2004-04.pdf)**
  Prescribing a Reporting System for the Submission of Regional Monthly Report on Wood Importation and Disposition
- **DMO 2004-01 (/images/policies/2004/dmo/memo_order2004-01.pdf)**
  Prescribing a Reporting System for the Submission of all Forestry Related Income Collection
  Monthly Collection Report on Forestry Fees and Charges

DENR MEMORANDUM CIRCULAR

- **DMC 2004-12 (/images/policies/2004/dmc/DMC2004-12.pdf)**
  Revised Guidelines Governing the Identification of Forest Areas for the Establishment of African Oil Palm (Elaeis guineensis Jacq.) Plantation
- **DMC 2004-08 (/images/policies/2004/dmc/DMC2004-08.pdf)**
  Instructions Relative to the Preparation and Affirmation of CRMF and Work Plans in CBFM Areas Already Issued with CBFM Agreements
- **DMC 2004-06 (/images/policies/2004/dmc/DMC2004-06.pdf)**
  Guidelines in the Integration of Rainforestation Farming Strategy in the Development of Open and Denuded Areas Within Protected Areas and Other Appropriate Forest Lands

2003 (/PDF/EO192S.1987.PDF)

DENR ADMINISTRATIVE ORDER

- **DAO 2003-53 (/images/policies/2003/dao/dao2003-53.pdf)**
  Further Amending Sections 11 and 12 of MNR Administrative order No. 50 Series of 1986 (Integrated Regulation on the Establishment and Operations of Wood Processing Plants
- **DAO 2003-42 (/images/policies/2003/dao/dao2003-42.pdf)**
  Interim Guidelines for the Establishment of a Special Use of Forestland for Herbal/ Medicinal Plantation

- **DAO 2003-41 (/images/policies/2003/dao/dao2003-41.pdf)**
  Amending Certain Provisions of MNR Administrative Order No. 50, dated November 19, 1986, (Integrated Regulation on the Establishment and Operations of Wood Processing Plants)
- **DAO 2003-24 (/images/policies/2003/dao/dao2003-24.pdf)**
  Implementing Rules and Regulations of RA 9175 Entitled "Chainsaw Act of 2002"
- **DAO 2003-21 (/images/policies/2003/dao/dao2003-21.pdf)**
  Amending Certain Provisions of DENR Administrative Order No. 99-53, (The Regulations Governing the Integrated Forest Management program)
- **DAO 2003-18 (/images/policies/2003/dao/dao2003-18.pdf)**
  Amendment to Section IX of DENR Administrative Order No. 2000-11, Re: Disposition of Forest Products
- **DAO 2003-17 (/images/policies/2003/dao/dao2003-17.pdf)**
  Addendum to Section 4 of DENR Administrative Order No. 99-46 Re: Inclusion of Subic bay, Zambales as the Port of Entry for Imported Wood Materials
- **DAO 2003-11 (/images/policies/2003/dao/dao2003-11.pdf)**
  Repealing DENR Administrative Order No. 99-29 which Amends Certain Provisions of DAO 96-29 Related to the Processing and Approval of Community-based Forest Management Agreement (CBFMA)
- **DAO 2003-05 (/images/policies/2003/dao/dao2003-05.pdf)**
  Revocation of Memorandum Order No. 99-29 and DENR Administrative Order No. 2001-03 which Prescribed the Guidelines in the Implementation of Usufruct Rights in Tree Farming

Appendix 6.8 Magsaysay Park Establishments Inventory

LIST OF FACILITIES OPERATING IN MAGSAYSAY PARK

EATERIES/RENTERS:

		Name of Establishment/Owner	Number of Personnel	Business Hours
E1	1	Vilma Zabala	7	13hrs (7am to 8pm)
E2	2	Rosalina Palopalo	8	13hrs(7am to 8pm)
E3	3	Mercedita Sosa	6	13hrs(7am to 8pm)
E4	4	Marideth Lim Snack Inn	2 + 2	8hrs(1pm to 9pm)
E5	5	Benjie Ranque	3 + 4	8hrs(8am to 5pm)
E6	6	South Mindanao Drug Test Center	3	8hrs(8am to 5pm)
E7	7	Royal Plains	1	8hrs(8am to 5pm)
E8	8	MERBIN Recruitment Agency	3	8 hrs./8am to 5pm

Park Attraction:

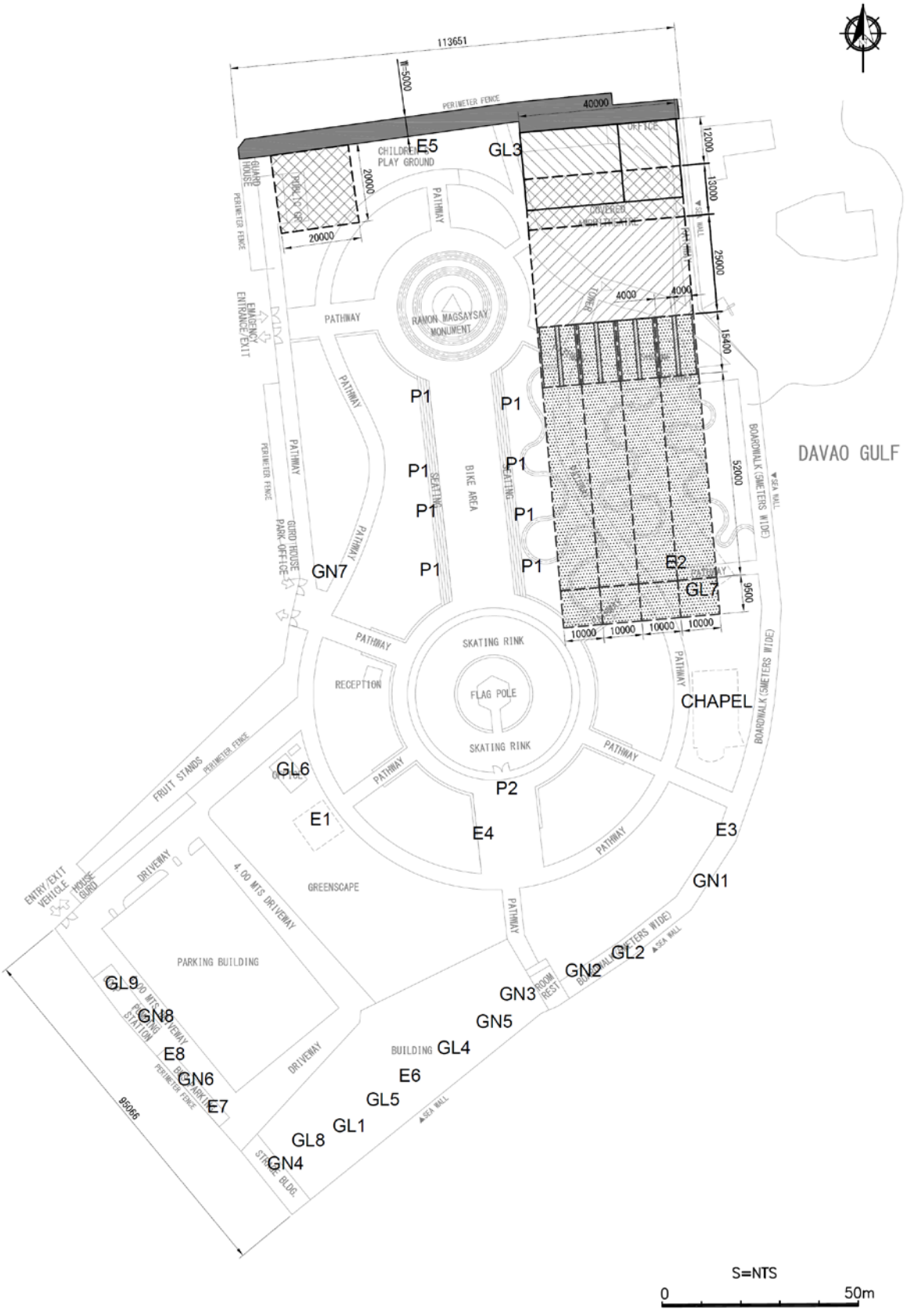
P1	1	Tribal Village	11	8hrs(8am to 5pm)
P2	2	Lim Skating & Bicycle Rink	3	8hrs(1pm to 9pm)

Government Offices (National):

GN1	1	Philippine Veterans Affairs Office	6	8hrs(8am to 5pm)
GN2	2	PNP-Internal Affairs Service	10	8hrs(8am to 5pm)
GN3	3	Commission on Election (COMELEC)	70	8hrs8am to 5pm)
GN4	4	Phil. Tourism Authority-Travel Tax	2	8hrs(8am to 5pm)
GN5	5	Criminal Investigation & Detection Group (CIDG)	22	24hrs
GN6	6	2202nd Reservist Group Phil. Army	12	24hrs
GN7	7	PNP Police & Police Auxilliary	6	24hrs
GN8	8	DPWH Pumping Station		

Government Offices (LGU):

GL1	1	CEE RMPark Management	25	8hrs(8am to 5pm)
GL2	2	CMO-Ancillary Services Unit (ASU)	169	24
GL3	3	City Environment &Natural Resources Office (CENRO)	50	6 hrs (6days a week/6am to 12nn)
GL4	4	Davao City Investment Promotion Center (DCIPC)	29	8hrs(8am to 5pm)
GL5	5	CEE Supply Office	7	8hrs(8am to 5pm)
GL6	6	CMO Anti-Smoking Office	9	8hrs(8am to 5pm)
GL7	7	Museo Dabawenyo Bodega	20	8hrs(8am to 5pm)
GL8	8	City Social Services Dev't. Office (CSSDO)	18	8hrs(8am to 5pm)
GL9	9	City Cooperative Dev't. Office	3	8hrs(8am to 5pm)



Location of Establishments

Appendix 6.9
Environmental Checklist: 15. Waste Water Treatment (Ver. 1 as of 20191024)

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td rowspan="2">1 Permits and Explanation</td><td>(1) EIA and Environmental Permits</td><td>(a) Have EIA reports been already prepared in official process?
(b) Have EIA reports been approved by authorities of the host country's government?
(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?
(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?</td><td>(a) N
(b) N
(c) N
(d) Y</td><td>(a) A matrix guideline for determining the category in which the projects fall is prepared and attached as “Annex A Project Thresholds for Coverage Screening and Categorization” in the “Revised Guidelines for Coverage Screening and Standardized Requirements under the PEISS, EMB MC 005 July 2014, EMB/DENR”. In accordance with the Annex A, sewerage system projects are subject to “3.8.5 Domestic wastewater treatment facility” under “3.8 Waste Management Projects” in “3. Infrastructure Projects” as shown in the following table.
<table>
<tr><th rowspan="3">Projects/Description</th><th colspan="3">Covered (Required to secure ECC)</th><th>Not covered (may secure CNC)</th><th rowspan="3">Project size parameters/ Remarks</th></tr>
<tr><th>Category A: ECP</th><th colspan="2">Category B: Non-ECP</th><th>Category D</th></tr>
<tr><th>EIS</th><th>EIS</th><th>IEE Checklist</th><th>PD (Part I only)</th></tr>
<tr><td colspan="6">3. INFRASTRUCTURE PROJECTS</td></tr>
<tr><td colspan="6">3.8 Waste Management Projects</td></tr>
<tr><td>3.8.5 Domestic wastewater treatment facility (inducing septage treatment facility)</td><td>None</td><td>≧5,000m^3</td><td>>30m^3 but <5,000m^3</td><td>≦30m^3</td><td>Based on system capacity</td></tr>
</table>
Source: Excerpt from “Annex A Project Thresholds for Coverage Screening and Categorization ” in “Revised Guidelines for Coverage Screening and Standardized Requirements under the PEISS, EMB MC 005 July 2014, Environmental Impact Assessmen and Management Division (EIAMD), EMB/DENR
As for sewer line systems, according to EMB/DENR, those lines are regarded as parts of the WWTP facilities. Therefore, the proposed project including sewer lines is classified as Category B (Non-ECP). In addition, the project site of Area A is located in “Areas frequently visited and/or hard-hit by natural calamities (geologic hazards, floods, typhoons, volcanic activity etc.)” specified in DAO 03-30. Therefore, the proposed project in Davao City is expected to fall under Environmentally Critical Areas ECAs). Based on the recognition above, the proposed project of Category B in ECA is required to secure ECC.
(b) Not applicable at the moment (An EIA study for EIS will be started after the final project design proposed at the Feasibility Study phase).
(c) Not applicable at the moment.
(d) Cutting of Trees is subject to PD (Presidential Decree) No. 705 (Revised Forestry Reform Code of the Philippines), RA (Republic Act) No. 3571 (Prohibit the Cutting, Destroying or Injuring of Planted or Growing Trees, Flowering Plants and Shrubs or Plants of Scenic Value Along Public Roads, in Plazas, Parks, School Premises or in Any Other Public Pleasure Ground), RA No. 10593 (Regulation of the Cutting of Coconut Trees, its replenishment, providing Penalties therefor, and for other purposes), and other relevant forest acts of DENR.</td></tr>
<tr><td>(2) Explanation to the Local Stakeholders</td><td>(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure?
Is understanding obtained from the Local stakeholders?</td><td>(a) N
(b) N</td><td>(a) Not applicable at the moment.
(b) Not applicable at the moment.</td></tr>
</table>

Appendix 6.9
Environmental Checklist: 15. Waste Water Treatment (Ver. 1 as of 20191024)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?		
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Based on technical reviews, and environmental and social situations several possible alternative sits in the Davao City have been examined.
2 Pollution Control	(1) Water Quality	(a) Do pollutants, such as SS, BOD, COD, pH contained in treated effluent from a sewage treatment plant comply with the country's effluent standards? (b) Does untreated water contain heavy metals?	(a) Y (b) N	(a) Each pollutant in the treated effluent by the proposed MBR technology is designed to be below the Country's effluent standards of DAO2016-08 Class SB (BOD_5 is 30 mg/L, COD is 60 mg/L, TSS is 70 mg/L, NO_3-N is 20 mg/L, Phosphate is 1 mg/L and Faecal Coliform is 200 mg/L). (b) Only domestic waste water will be treated in the proposed WWTP (Industrial waste water which may contain heavy metals is out of scope in the proposed Project)
	(2) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed of in accordance with the country's standards?	(a) Y	(a) After the de-watering of the sludge will be disposed of at a landfill site (two candidate sites for landfill are being investigated by CENRO) in Davao in accordance with the country's standards.
	(3) Soil Contamination	(a) If wastes, such as sludge are suspected to contain heavy metals, are adequate measures taken to prevent contamination of soil and groundwater by leachates from the wastes?	(a) Y	(a) Only domestic waste water will be treated in the proposed WWTP (Industrial waste water which may contain heavy metals is out of scope in the proposed Project)
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as sludge treatment facilities and pumping stations comply with the country's standards?	(a) Y	(a) Pump planned to be installed at the WWTP is submerged type which can reduced the noise and vibration appropriately.
	(5) Odor	(a) Are adequate control measures taken for odor sources, such as sludge treatment facilities?	(a) Y	(a) No national standards on offensive odor in the Philippines. On the other hand, the proposed project may refer to the Maynilad Water Service Inc.'s (water and wastewater services provider in the Philippines) internal guidelines on odor control of "Employer's Requirement for Plant Odor control system". In addition, the Maynilad has technical conventional designs on odor controls in WWTPs.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) The proposed Project site of the Magsaysay Park in Davao City is not located in such protected areas at all.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	(a) N (b) N (c) N (d) N	(a) Not applicable (The proposed project site does not encompass such ecosystem) (b) Not applicable (The proposed project site does not encompass such ecosystem) (c) Not applicable (The proposed project site does not encompass such ecosystem) (d) Not applicable (Domestic waste water is to be treated in proposed WWTP)

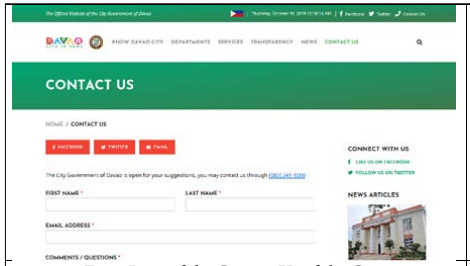
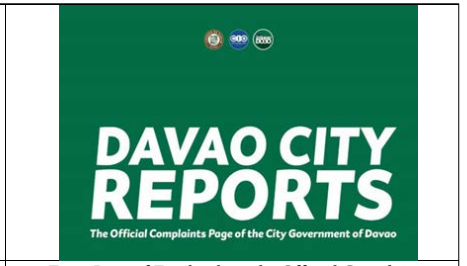
Appendix 6.9
Environmental Checklist: 15. Waste Water Treatment (Ver. 1 as of 20191024)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(d) Is there a possibility that the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?		
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N	(a) Involuntary resettlement is not occurred caused by the project implementation because that the proposed project site for WWTP is on the premises of the Magsaysay park as well as the sewer pipes are constructed under the existing roads. However, some of the commercial and governmental facilities (namely No. E2 in which eight private people work, No. GL 7 in which 20 LGU officials work, and No. GL 3 in which 50 LGU officials work) in the Magsaysay park are to be demolished based on the proposed layout of the WWTP to be constructed. According to the City of Davao, procedures on actions against those impacts on the businesses including demolition and/or relocation of the facilities occurred by the WWTP construction in the park come into compliance with the relevant laws and regulations as shown below. ・ Republic Act No. 7279: IRR to "Ensure the Observance of Proper and Human Relocation and Resentment Procedures manded by the Urban Development and Housing Act of 1992" of the Department of Interior and Local Government (DILG) and the Housing and Urban Development Coordinating Council (HUDCC). ・ Republic Act No. 10752: Act Facilitating the Acquisition of Right-of-Way Site or Location for National Government Infrastructure Projects ・ DPWH D.O. No. 327 (series of 2003) *(* In case of NSSMP): Guidelines for Land Acquisition and Resettlement Action Plan (LAPRAP) for Infrastructure Projects On the other hand some of trees planted in the park may be subject to be cut depending on the lay out of the WWTP facility. As specified in (1) EIA and Environmental Permits, cutting of trees is subject to relevant laws and regulations of the Philippines. (b) Not Yet (c) Not Yet (d) Not Yet (e) Not Yet (f) Not Yet (g) Not Yet (h) Not Yet (i) Not Yet (j) Not Yet
	(2) Living and Livelihood	(a) Is there a possibility that changes in land uses and water uses due to the project will adversely affect the living conditions of inhabitants? (b) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if	(a) N (b) Y	(a) Not applicable (b) Workers for commercial and governmental facilities (namely No. E2 in which eight private people work, No. GL 7 in which 20 LGU officials work, and No. GL 3 in which 50 LGU officials work) in the Magsaysay park are to be impacted (unemployed, temporally lay-offed or job transfers) caused by the proposed layout of the WWTP to be constructed.

Appendix 6.9
Environmental Checklist: 15. Waste Water Treatment (Ver. 1 as of 20191024)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		necessary?		
	(3) Heritage	(a) Is there a possibility that the project will damage the local archaeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) Not applicable
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) Not applicable (WWTP is proposed to be constructed underground as well as the sewer pipes are constructed under the existing roads).
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to lands and resources respected?	(a) N (b) N	(a) Not applicable (b) Not applicable
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a)(b)(c)(d) Following laws and regulations on working conditions are to be applied for construction projects in the Philippines 1. Presidential Decree 422 (1974), as Amended "Labor Code of the Philippines" This law states the responsibility of the Department of Labor and Employment (DOLE) as the agency to set and monitor safety and health standards in all workplaces. (Please refer to Page 28, Article 162 of Attachment 1: 1974_PD442_Labor Code) 2. DOLE Occupational Safety and Health Standards (As Amended, 1989) This contains all relevant standards on Occupational Safety and Health Standards (OSHS) in workplaces, accident prevention measures, etc., specifically under Rule 1060 to Rule 1960. (Please refer to Attachment 2: 1989_DOLE OSHS) 3. DOLE Department Order 13, Series of 1998 This contains guidelines covering OSHS specifically for construction industry. (Please refer to Attachment 3: 1998_DOLE DO13) 4. DOLE Department Order 16, Series of 2001 This contains amendments to OSHS Rule 1030 on Training of Personnel in Occupational Safety and Health. (Please refer to Attachment 4: 2001_DOLE DO16) 5. DOLE Department Order No. 128-13, Series of 2013 This contains amendments to OSHS Rule 1414 on Scaffoldings. (Please refer to Attachment 5: 2013_DOLE DO128)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?(c) If	(a)(b) (c)(d) Y	(a)(b)(c)(d) During construction phase relevant laws and regulations such as "1978 NPCC Rules and Regulations Implementing PD 984 (noise)", IRR "NATIONAL BUILDING CODE OF THE PHILIPPINES (PD 1096)" and others are applied.

Appendix 6.9
Environmental Checklist: 15. Waste Water Treatment (Ver. 1 as of 20191024)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?(d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?		
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) N (b) Y (c) N (d) Y	(a) The City of Davao does not have a specific section which is handling operation on environmental and social considerations including the monitoring activities for their projects. As for the grievance redress, the City Government is open for people's suggestions. Namely, those who would like to express their opinions and grievances can communicate with the City through the hot-line telephone, e-mail and other social networking services as shown in the following figures.  Front Page of the Contact Us of the City  Front Page of Facebook on the Official Complaints Among those, the Facebook page of "Davao City Report" is the "Official Complaints Page of the City Government of Davao" launched in 2017. The page maintained by the City Information Office, which will also forward the collated reports to the concerned offices and agencies for necessary actions. (b) PEISS requires and regulate environmental monitoring actives for the ECC projects (c) The City of Davao does not have a specific section which is handling operation on environmental and social considerations including the monitoring activities for their projects. (d) PEISS requires and regulate environmental monitoring actives and reporting systems for the ECC projects
6 Note	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) Not applicable

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)

experience).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

Appendix 7.1 Flow Calculation Sheet and Longitudinal Profile of Trunk Sewers for Phase-1

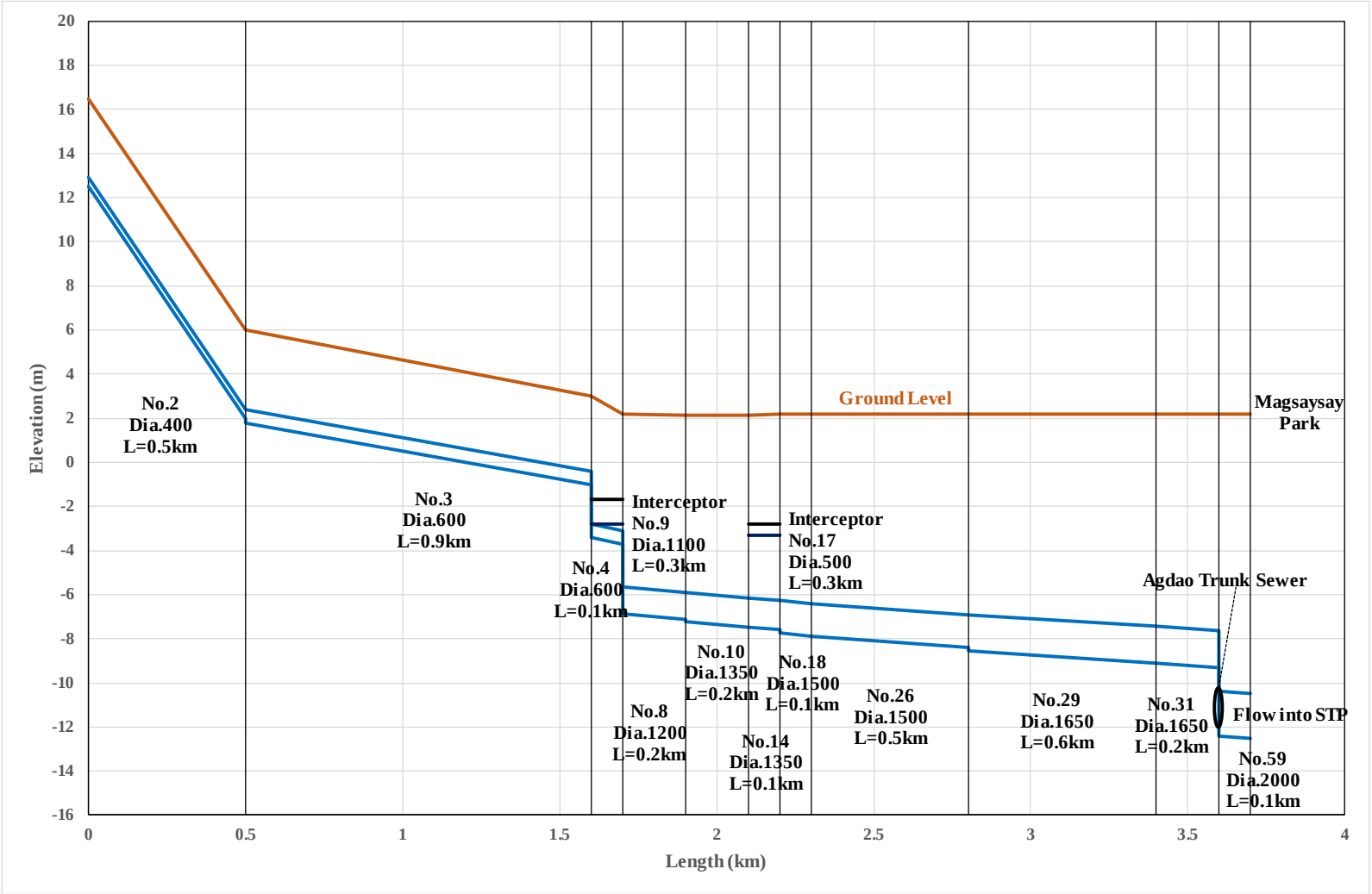
(1) Flow Calculation

Table 1: Flow Calculation

Sewer No.	Barangay	Downstream Sewer No.	Hourly Maximum Sewage Flow (m3/s)	Accumulated Sewage Flow (m3/s)	Diameter (mm)		Slope (%)	$s^{1/2}$	$R^{2/3}$	v (m/s)	Q_f (m3/s)	Length (km)	GL (m)		Elevation of bottom of pipe (m)		Depth of Excavation (m)	
					Minimum	Apply							Up	Down	Up	Down	Up	Down
1	40-D	4	0.016	0.016	180	400	0.364	0.060	0.215	1.000	0.126	0.8	4.0	3.0	0.0	-3.2	4.0	6.2
2	5-A		0.077	0.077	390	400	0.364	0.060	0.215	1.000	0.126	0.5	16.5	6.0	12.5	2.0	4.0	4.0
3	2-A		0.024															
	1-A		0.021	0.122	490	600	0.212	0.046	0.282	1.000	0.283	1.1	6.0	3.0	1.8	-1.0	4.2	4.0
4	39-D	8	0.035	0.173	580	600	0.212	0.046	0.282	1.000	0.283	0.1	3.0	2.2	-3.4	-3.7	6.4	5.9
5	6-A		0.014	0.014	170	200	0.917	0.096	0.136	1.000	0.031	0.5	16.5	6.0	12.5	2.0	4.0	4.0
6	3-A		0.003	0.017	190	200	0.917	0.096	0.136	1.000	0.031	0.6	6.0	3.5	2.0	-3.7	4.0	7.2
7	38-D		0.010	0.027	230	250	0.681	0.083	0.157	1.000	0.049	0.3	3.5	2.2	-3.8	-5.9	7.3	8.1
8		10		0.766	1,210	1200	0.084	0.029	0.448	0.999	1.130	0.2	2.2	2.1	-6.9	-7.1	9.1	9.2
9	Bucana		0.566	0.566	1,040	1100	0.095	0.031	0.423	1.003	0.953	0.3	1.6	2.2	-2.4	-2.8	4.0	5.0
10		14		1.332	1,600	1350	0.072	0.027	0.485	1.001	1.432	0.2	2.1	2.1	-7.3	-7.5	9.4	9.6
11	4-A		0.011	0.011	150	400	0.364	0.060	0.215	1.000	0.126	0.7	4.1	3.2	0.1	-2.7	4.0	5.9
12	35-D		0.004	0.015	170	400	0.364	0.060	0.215	1.000	0.126	0.3	3.2	2.8	-2.7	-3.9	5.9	6.7
13	36-D		0.011	0.026	230	400	0.364	0.060	0.215	1.000	0.126	0.3	2.8	2.2	-3.9	-5.1	6.7	7.3
14		18		1.358	1,620	1350	0.072	0.027	0.485	1.001	1.432	0.1	2.1	2.2	-7.5	-7.6	9.6	9.8
15	34-D		0.011	0.011	150	400	0.364	0.060	0.215	1.000	0.126	0.6	3.3	2.8	-0.7	-3.1	4.0	5.9
16	33-D	18	0.014	0.025	220	400	0.364	0.060	0.215	1.000	0.126	0.6	2.8	2.2	-3.1	-5.5	5.9	7.7
17	37-D		0.045	0.045														
	31-D		0.056	0.101	440	500	0.270	0.052	0.250	0.999	0.196	0.3	1.6	2.2	-2.4	-3.3	4.0	5.5
18		26		1.484	1,690	1500	0.062	0.025	0.520	0.996	1.760	0.1	2.2	2.2	-7.8	-7.9	10.0	10.1
19	7-A	22	0.027	0.027	230	400	0.200	0.045	0.215	0.741	0.093	0.5	4.1	3.5	0.1	-1.1	4.0	4.6
20	9-A	22	0.038	0.038	270	400	0.270	0.052	0.215	0.861	0.108	0.8	3.9	3.5	-0.1	-2.6	4.0	6.1
21	10-A		0.046	0.046	300	400	0.270	0.052	0.215	0.861	0.108	1	4.1	3.5	0.1	-3.0	4.0	6.5
22		24		0.111	470	500	0.270	0.052	0.250	0.999	0.196	0.2	3.5	3.3	-3.1	-3.7	6.6	7.0
23	11-B		0.013	0.013	160	400	0.260	0.051	0.215	0.845	0.106	1	4.2	3.3	0.2	-2.8	4.0	6.1
24	29-C		0.011	0.135	510	600	0.212	0.046	0.282	1.000	0.283	0.7	3.3	2.6	-3.8	-5.6	7.1	8.2
25	24-C		0.018	0.153	550	600	0.212	0.046	0.282	1.000	0.283	0.6	2.6	2.2	-5.6	-7.1	8.2	9.3
26	25-C	29	0.013	1.65	1,780	1500	0.062	0.025	0.520	0.996	1.760	0.5	2.2	2.2	-7.9	-8.4	10.1	10.6
27	28-C	29	0.015	0.015	170	400	0.200	0.045	0.215	0.741	0.093	0.5	2.6	2.2	-1.4	-2.6	4.0	4.8
28	21-C		0.05															
	22-C		0.045															
	23-C		0.111	0.206	630	700	0.173	0.042	0.313	1.001	0.385	0.5	1.6	2.2	-2.4	-3.5	4.0	5.7
29	26-C	31	0.017	1.888	1,900	1650	0.055	0.023	0.554	1.000	2.138	0.6	2.2	2.2	-8.6	-9.1	10.8	11.3
30	30-C		0.011	0.011	150	400	0.364	0.060	0.215	1.000	0.126	1.4	3.0	2.2	-1.0	-6.7	4.0	8.9
31		59		1.899	1,910	1650	0.055	0.023	0.554	1.000	2.138	0.2	2.2	2.2	-9.1	-9.3	11.3	11.5
32	27-C	59	0.015	0.015	170	400	0.364	0.060	0.215	1.000	0.126	1.4	3.2	2.2	-0.8	-6.5	4.0	8.7

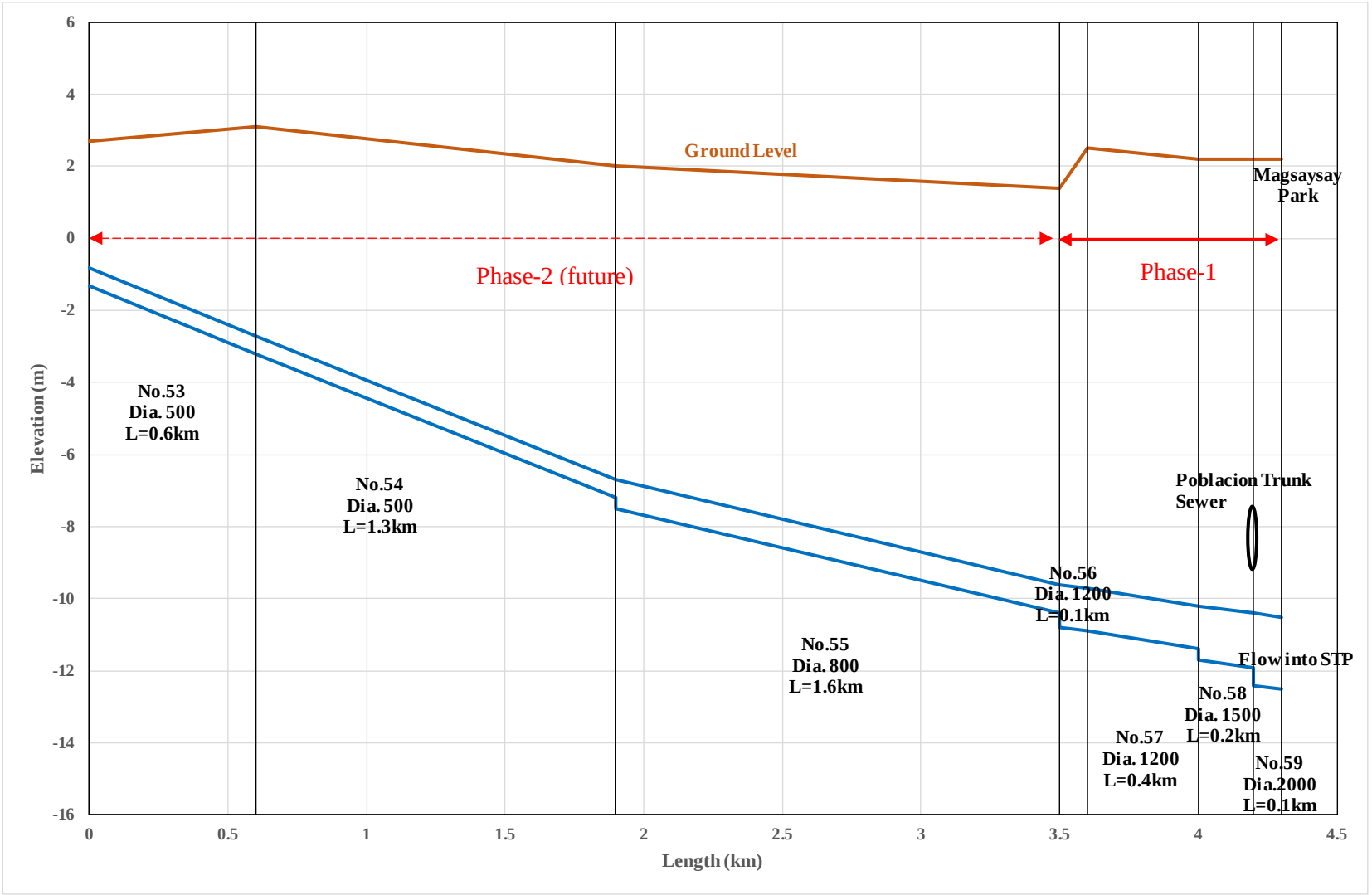
Sewer No.	Barangay	Downstream Sewer No.	Hourly Maximum Sewage Flow (m3/s)	Accumulated Sewage Flow (m3/s)	Diameter (mm)		Slope (%)	$s^{1/2}$	$R^{2/3}$	v (m/s)	Q_f (m3/s)	Length (km)	GL (m)		Elevation of bottom of pipe (m)		Depth of Excavation (m)	
					Minimum	Apply							Up	Down	Up	Down	Up	Down
34	20-B		0.031	0.031	250	400	0.364	0.060	0.215	1.000	0.126	1	8.0	5.0	4.0	0.0	4.0	5.0
35				0.245	690	700	0.173	0.042	0.313	1.001	0.385	0.8	5.0	3.5	-0.3	-2.0	5.3	5.5
36	12-B		0.006	0.251	700	800	0.144	0.038	0.342	0.998	0.502	0.6	3.5	2.8	-2.1	-3.2	5.6	6.0
37		40		0.251	700	800	0.144	0.038	0.342	0.998	0.502	0.6	2.8	2.4	-3.2	-4.3	6.0	6.7
38	13-B		0.005	0.005	100	400	0.200	0.045	0.215	0.741	0.093	0.1	3.5	2.5	-0.5	-0.7	4.0	3.2
39	14-B		0.008	0.013	160	400	0.200	0.045	0.215	0.741	0.093	1.2	2.5	2.4	-0.7	-3.6	3.2	6.0
40	Kept. Tomas	58	0.039	0.303	770	800	0.144	0.038	0.342	0.998	0.502	0.7	2.4	2.2	-4.3	-5.6	6.7	7.8
41	18-B		0.012	0.012	160	400	0.300	0.055	0.215	0.908	0.114	0.6	3.9	2.4	-0.1	-2.1	4.0	4.5
42		44		0.012	160	400	0.200	0.045	0.215	0.741	0.093	0.3	2.4	1.6	-2.1	-2.8	4.5	4.4
43	17-B		0.005	0.005	100	400	0.200	0.045	0.215	0.741	0.093	0.6	2.5	1.6	-1.5	-2.9	4.0	4.5
44		47		0.017	190	400	0.200	0.045	0.215	0.741	0.093	0.9	1.6	1.8	-2.9	-5.1	4.5	6.9
45	16-B		0.006															
	15-B		0.020	0.026	230	400	0.230	0.048	0.215	0.795	0.100	0.8	2.1	1.6	-1.9	-4.1	4.0	5.7
46				0.026	230	400	0.230	0.048	0.215	0.795	0.100	0.3	1.6	1.8	-4.1	-4.9	5.7	6.7
47		57		0.043	290	400	0.200	0.045	0.215	0.741	0.093	0.2	1.8	2.5	-5.1	-5.6	6.9	8.1
48	Gov. Paciano	56	0.061	0.061	350	400	0.364	0.060	0.215	1.000	0.126	1.7	4.0	1.4	0.0	-6.9	4.0	8.3
56				0.570	1,050	1200	0.084	0.029	0.448	0.999	1.130	0.1	1.4	2.5	-10.8	-10.9	12.2	13.4
57	Leon Garcia		0.094	0.707	1,170	1200	0.084	0.029	0.448	0.999	1.130	0.4	2.5	2.2	-10.9	-11.4	13.4	13.6
58		59		1.010	1,390	1500	0.062	0.025	0.520	0.996	1.760	0.2	2.2	2.2	-11.7	-11.9	13.9	14.1
59				2.924	2,370	2000	0.043	0.021	0.630	1.005	3.157	0.1	2.2	2.2	-12.4	-12.5	14.6	14.7
To WWTP																		
											Total	28.7						

Source: JICA Survey Team



Source: JICA Survey Team

Figure-1: Poblacion Trunk Sewer



Source: JICA Survey Team

Figure-2: Agdao Trunk Sewer

Appendix 7.2 Detailed Planning Parameters for Stepwise Sewer Development (Phase-I Sanitary Sewer, Interceptor, Phase-II Sanitary Sewer)

District	Barangay	Total								Phase I																				Phase II (remaining)				Total (After Phase II)
										Sanitary Sewer Collection										Intercepter (Tentative) Collection			Total								Sanitary Sewer Collection				
		Land Area	Population			No. of HH		Wastewater (Daily Maximum) (m3/day)		Connected Population Ratio	Connected Population		Wastewater flow (m3/day)		Sewered Area Ratio	Sewered Area	Sanitary Sewer Length	Sanitary Sewer Length	Pilot Area	Collected BOD load	Intercepted Drain	Wastewater flow (m3/day)	Collected BOD load	Assumed connection ratio	Population			Inflow to WWTP (m3/day)		Connected Population	Wastewater flow (m3/day)	Additional Sewered Area	Sanitary Sewer Length	Sanitary Sewer Length
		(ha)	(2015)	(2030)	(2045)	(2030)	(2045)	(2030)	(2045)	(%)	(2030)	(2045)	(2030)	(2045)	(%)	(ha)	(km)	(km)		(kg/day)		(2045)	(kg/day)	(%)	(2015)	(2030)	(2045)	(2030)	(2045)	(2045)	(2045)	(ha)	(km)	(km)
Poblacion	1-A	15.36	3,103	3,352	3,719	701	778	838	974	60%	2,011	2,232	503	527	80%	12.28	2.1	0.8		66.9				80%	2,482	2,682	2,975	503	527	1,708	447	3.07	0.5	1.4
	2-A	16.38	3,589	3,877	4,302	811	900	969	1,127	60%	2,326	2,581	582	609	80%	13.10	2.2	2.1		77.4				80%	2,871	3,102	3,441	582	609	1,975	518	3.28	0.6	2.6
	3-A	20.78	370	400	443	84	93	100	116	100%	400	443	100	105	100%	20.78	3.5	3.3		13.3				100%	370	400	443	100	105	44	11	0.00	0.0	3.3
	4-A	23.51	1,683	1,818	2,017	380	422	455	529	100%	1,818	2,017	455	476	100%	23.51	4.0	2.2		60.5				100%	1,683	1,818	2,017	455	476	199	52	0.00	0.0	2.2
	5-A	38.10	11,436	12,354	13,707	2,585	2,868	3,089	3,591	100%	12,354	13,707	3,089	3,237	100%	38.10	6.5	7.2		411.2				100%	11,436	12,354	13,707	3,089	3,237	1,353	354	0.00	0.0	7.2
	6-A	15.00	2,084	2,251	2,498	471	523	563	654	100%	2,251	2,498	563	590	100%	15.00	2.6	1.5		74.9				100%	2,084	2,251	2,498	563	590	247	65	0.00	0.0	1.5
	7-A	22.50	3,984	4,304	4,775	900	999	1,076	1,251	100%	4,304	4,775	1,076	1,128	100%	22.50	3.8	3.6		143.3				100%	3,984	4,304	4,775	1,076	1,128	471	123	0.00	0.0	3.6
	9-A	27.50	5,698	6,155	6,830	1,288	1,429	1,539	1,789	100%	6,155	6,830	1,539	1,613	100%	27.50	4.7	4.6		204.9				100%	5,698	6,155	6,830	1,539	1,613	674	177	0.00	0.0	4.6
	10-A	28.64	6,764	7,307	8,107	1,529	1,696	1,827	2,124	100%	7,307	8,107	1,827	1,914	100%	28.64	4.9	3.5		243.2				100%	6,764	7,307	8,107	1,827	1,914	800	210	0.00	0.0	3.5
	11-B	9.57	1,901	2,054	2,279	430	477	513	597	100%	2,054	2,279	513	538	100%	9.57	1.6	1.3		68.4				100%	1,901	2,054	2,279	513	538	225	59	0.00	0.0	1.3
	12-B	17.54	840	907	1,007	190	211	227	264	100%	907	1,007	227	238	100%	17.54	1.5	1.5		30.2				100%	840	907	1,007	227	238	99	26	0.00	0.0	1.5
	13-B	11.26	427	461	512	97	107	115	134	100%	461	512	115	121	100%	11.26	1.9	1.1		15.4				100%	427	461	512	115	121	51	13	0.00	0.0	1.1
	14-B	18.41	1,175	1,269	1,408	266	295	317	369	100%	1,269	1,408	317	333	100%	18.41	3.1	1.8		42.3				100%	1,175	1,269	1,408	317	333	139	36	0.00	0.0	1.8
	15-B	31.54	2,891	3,123	3,465	653	725	781	908	100%	3,123	3,465	781	818	100%	31.54	5.4	4.0		104.0				100%	2,891	3,123	3,465	781	818	342	90	0.00	0.0	4.0
	16-B	5.53	840	907	1,007	190	211	227	264	100%	907	1,007	227	238	100%	5.53	0.9	1.5		30.2				100%	840	907	1,007	227	238	99	26	0.00	0.0	1.5
	17-B	5.63	810	875	971	183	203	219	254	100%	875	971	219	229	100%	5.63	1.0	1.3		29.1				100%	810	875	971	219	229	96	25	0.00	0.0	1.3
	18-B	19.80	1,832	1,979	2,196	414	459	495	575	100%	1,979	2,196	495	519	100%	19.80	3.4	3.6		65.9				100%	1,832	1,979	2,196	495	519	217	57	0.00	0.0	3.6
	19-B	362.55	31,766	34,316	38,074	7,179	7,965	8,579	9,976		0	0	0	0		0.00	0.0	0.0		0.0				0%	0	0	0	0	0	38,074	9,976	362.55	61.6	61.6
	20-B	56.58	4,581	4,949	5,491	1,035	1,149	1,237	1,439	100%	4,949	5,491	1,237	1,297	100%	56.58	4.8	8.5		164.7				100%	4,581	4,949	5,491	1,237	1,297	542	142	0.00	0.0	8.5
	21-C	8.56	7,478	8,078	8,963	1,690	1,875	2,020	2,348	40%	3,231	3,585	808	847	60%	5.14	0.9	0.9		107.6				60%	4,487	4,847	5,378	808	847	5,732	1,502	3.43	0.6	1.5
	22-C	8.71	6,634	7,167	7,951	1,499	1,663	1,792	2,083	40%	2,867	3,181	717	751	60%	5.23	0.9	0.9		95.4				60%	3,980	4,300	4,771	717	751	5,085	1,332	3.48	0.6	1.5
	23-C	21.31	16,489	17,813	19,764	3,727	4,135	4,453	5,178	20%	3,563	3,953	891	933	40%	8.53	1.4	1.4		118.6				40%	6,596	7,125	7,905	891	933	16,201	4,245	12.79	2.2	3.6
	24-C	7.72	2,602	2,811	3,119	588	652	703	817	100%	2,811	3,119	703	736	100%	7.72	1.3	0.7		93.6				100%	2,602	2,811	3,119	703	736	308	81	0.00	0.0	0.7
	25-C	4.96	1,967	2,125	2,358	445	493	531	618	100%	2,125	2,358	531	557	100%	4.96	0.8	1.0		70.7				100%	1,967	2,125	2,358	531	557	233	61	0.00	0.0	1.0
	26-C	8.05	2,510	2,712	3,008	567	629	678	788	100%	2,712	3,008	678	710	100%	8.05	1.4	1.4	Partly	90.3				100%	2,510	2,712	3,008	678	710	297	78	0.00	0.0	1.4
	27-C	30.99	2,152	2,325	2,579	486	540	581	676	100%	2,325	2,579	581	609	100%	30.99	5.3	3.8	All	77.4				100%	2,152	2,325	2,579	581	609	255	67	0.00	0.0	3.8
	28-C	15.71	2,270	2,452	2,721	513	569	613	713	100%	2,452	2,721	613	642	100%	15.71	2.7	2.6	Partly	81.6				100%	2,270	2,452	2,721	613	642	269	70	0.00	0.0	2.6
	29-C	10.20	1,557	1,682	1,866	352	390	421	489	100%	1,682	1,866	421	441	100%	10.20	1.7	1.2	Partly	56.0				100%	1,557	1,682	1,866	421	441	184	48	0.00	0.0	1.2
	30-C	23.50	1,608	1,737	1,927	363	403	434	505	100%	1,737	1,927	434	455	100%	23.50	4.0	3.5	All	57.8				100%	1,608	1,737	1,927	434	455	190	50	0.00	0.0	3.5
	31-D	22.60	8,321	8,989	9,973	1,881	2,087	2,247	2,613	40%	3,596	3,989	899	942	60%	13.56	2.3	2.3		119.7	Mabini MD	784	30	90%	7,489	8,090	8,976	1,683	1,726	6,378	1,671	9.04	1.5	3.8
	32-D	17.90	1,985	2,144	2,379	449	498	536	623	100%	2,144	2,379	536	562	100%	17.90	3.0	4.2		71.4				100%	1,985	2,144	2,379	536	562	235	62	0.00	0.0	4.2
	33-D	7.74	2,033	2,196	2,437	459	510	549	638	100%	2,196	2,437	549	575	100%	7.74	1.3	0.9		73.1				100%	2,033	2,196	2,437	549	575	241	63	0.00	0.0	0.9
	34-D	19.63	1,682	1,817	2,016	380	422	454	528	100%	1,817	2,016	454	476	100%	19.63	3.3	2.0		60.5				100%	1,682	1,817	2,016	454	476	199	52	0.00	0.0	2.0
	35-D	7.00	578	624	693	131	145	156	182	100%	624	693	156	164	100%	7.00	1.2	1.0		20.8				100%	578	624	693	156	164	68	18	0.00	0.0	1.0
	36-D	6.93	1,581	1,708	1,895	357	396	427	496	100%	1,708	1,895	427	447	100%	6.93	1.2	1.0		56.8				100%	1,581	1,708	1,895	427	447	187	49	0.00	0.0	1.0
	37-D	7.10	6,740	7,281	8,079	1,523	1,690	1,820	2,117	60%	4,369	4,847	1,092	1,145	80%	5.68	1.0	1.0		145.4				80%	5,392	5,825	6,463	1,092	1,145	3,710	972	1.42	0.2	1.2
	38-D	9.00	1,505	1,626	1,804	340	377	406	473	100%	1,626	1,804	406	426	100%	9.00	1.5	1.6		54.1				100%	1,505	1,626	1,804	406	426	178	47	0.00	0.0	1.6
	39-D	12.80	5,143	5,556	6,164	1,162	1,290	1,389	1,615	60%	3,334	3,699	833	873	80%	10.24	1.7	1.7		111.0				80%	4,114	4,445	4,931	833	873	2,831	742	2.56	0.4	2.2
	40-D	10.02	2,437	2,633	2,921	551	611	658	765	100%	2,633	2,921	658	690	100%	10.02	1.7	1.3		87.6				100%	2,437	2,633	2,921	658	690	288	76	0.00	0.0	1.3
Talomo	Bucana (East)	120.60	25,189	35,009	49,558	7,324	10,368	8,752	12,984	40%	14,004	19,823	3,501	3,669	60%	72.36	12.3	12.3		594.7	Bucana MD	2,597	99	80%	20,151	28,007	39,646	6,098	6,266	35,554	9,315	48.24	8.2	20.5
	Sub-Total	1,099.70	188,235	211,145	244,984	44,173	51,252	**52,786**	**64,186**		119,006	136,325	29,752	31,180		677.33	108.8	100.0		4089.8		3,381	129		131,346	148,129	172,923	33,132	34,560	125,978	33,006	449.86	76.5	176.5
Agdao	Agdao Proper	38.29	8,897	9,683	10,857	2,026	2,271	2,421	2,845	40%	3,873	4,343	968	1,015	40%	15.32	2.6	2.6		130.3				40%	3,559	3,873	4,343	968	1,015	6,984	1,830	22.97	3.9	6.5
	Tomas Monteverde	19.52	5,716	6,221	6,975	1,301	1,459	1,555	1,828	40%	2,488	2,790	622	652	40%	7.81	1.3	1.3	All	83.7	No Name	548	21	70%	4,001	4,355	4,883	1,170	1,200	4,487	1,176	11.71	2.0	3.3
	Leon Garcia	19.03	13,652	14,858	16,660	3,108	3,485	3,714	4,365	20%	2,972	3,332	743	779	20%	3.81	1.3	1.3		100.0	No Name	873	33	40%	5,461	5,943	6,664	1,616	1,652	13,688	3,586	15.22	2.6	3.9
	Paciano Bangoy	81.47	8,816	9,595	10,758	2,007	2,251	2,399	2,819	30%	2,878	3,228	720	754	30%	24.44	4.2	4.2		96.8				30%	2,645	2,878	3,228	720	754	7,880	2,065	57.03	9.7	13.8
	Wilfredo Aquino	72.26	9,903	10,778	12,085	2,255	2,528	2,694	3,166																					12,085	3,166	72.26	12.3	12.3
	Centro San Juan	43.48	15,586	16,963	19,020	3,549	3,979	4,241	4,983																					19,020	4,983	43.48	7.4	7.4
	Lapu Lapu	59.99	11,738	12,775	14,324	2,673	2,997	3,194	3,753																					14,324	3,753	59.99	10.2	10.2
	Rafael Castillo	44.54	5,783	6,294	7,057	1,317	1,476	1,573	1,849																					7,057	1,849	44.54	7.6	7.6
	San Antonio	89.88	10,306	11,216	12,577	2,347	2,631	2,804	3,295																					12,577	3,295	89.88	15.3	15.3
	Ubalde	9.98	2,966	3,228	3,620	675	757	807	948																					3,620	948	9.98	1.7	1.7
	Gov.Vicente Duterte	52.02	8,904	9,690	10,866	2,027	2,273	2,423	2,847																					10,866	2,847	52.02	8.8	8.8
	Sub-Total	593.00	102,267	111,300	124,800	23,285	26,109	27,825	32,698		12,211	13,693	3,053	3,199		51.37	9.4	9.4		410.8		1,421	54		15,666	17,049	19,117	4,474	4,621	112,589	29,498	593.00	81.4	90.8
	Total (Area A)	1,692.70	290,502	322,445	369,784	67,457	77,361	80,611	96,883		131,218	150,018	**32,804**	34,379		728.70	118.2	109.4		4500.5		4,802	183		147,012	165,178	192,041	37,606	39,181	238,566	62,504	1,042.86	157.9	**267.3**
								80,000	**97,000**																				**38,000**	40,000					

Source: JICA Survey Team

APPENDIX 7.3_INTRODUCTION OF VARIOUS INTERCEPTION CHAMBERS

(1) Types in Japan with Weirs

There are various types of interception chamber (combined sewer overflow: CSO) in Japan depending on site condition, pipe dimensions, and flow condition. Four examples are introduced below.

These type can avoid the clogging of chamber with sand/silt/garbage with enough large interceptor diameter. Meanwhile, too much sand/silt/garbage will flow down the sewer pipeline and may affect the function of downstream pumping station. Flushing force to sediments in drains in heavy rainfall events are slightly interfered but such garbage can be collected from the chambers with periodical cleaning without discharging to public water body. With this system both of sewerage function and drainage functions will not stop except for the case of clogging of interceptor due to too small diameter or clogging of chamber itself due to no cleaning for a long time. (in Japan such clogging rarely occurs due to much less dumping of garbage to road/sewer pipe).

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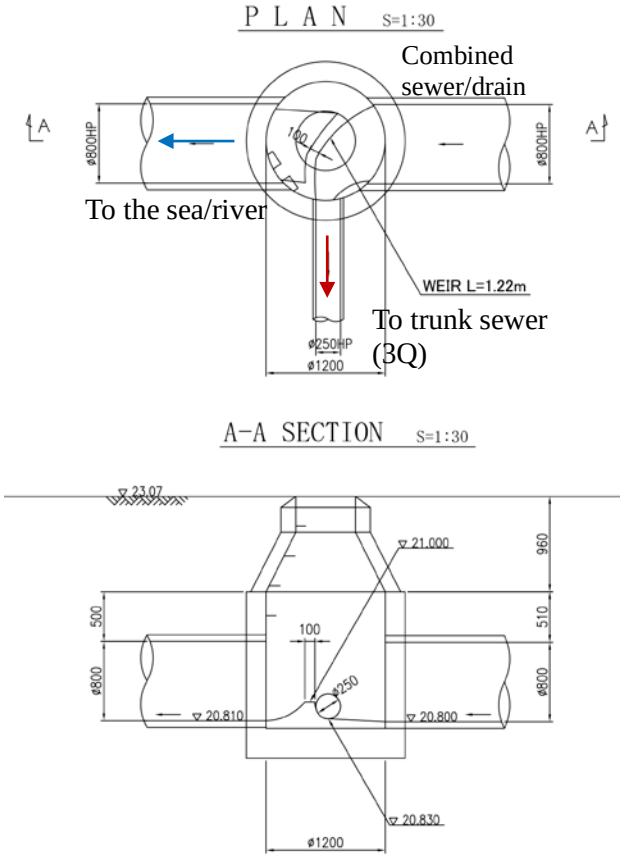
<td> 
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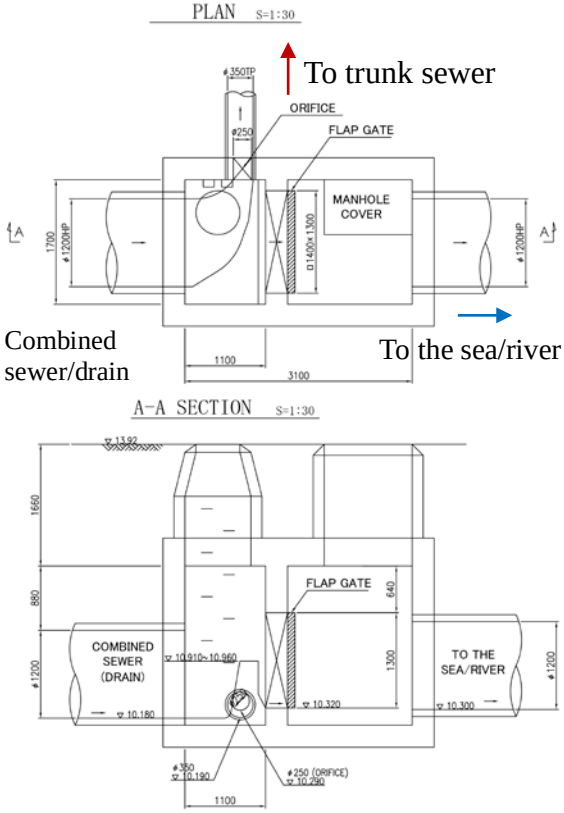
<td> 
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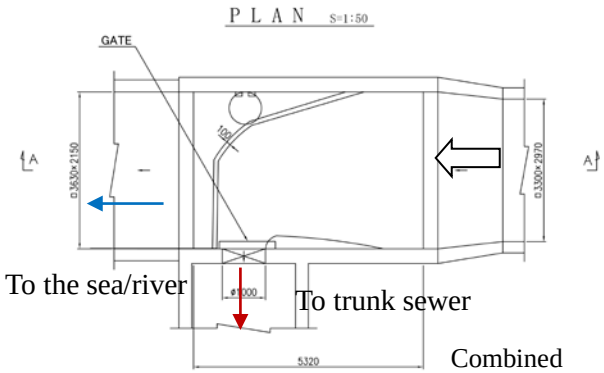
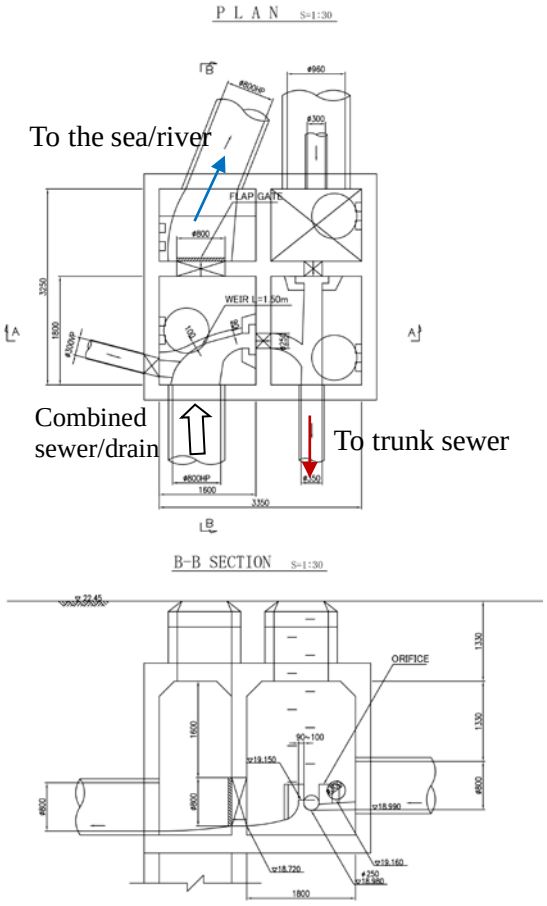
<tr>
<td>Example 1:
Most simple structure with round shape manhole</td>
<td>Example 2:
2 rooms manhole (step type weir)
Flap gate to stop backflow from river
Orifice to avoid too much interception in rainfall</td>
</tr>
</table>



Example 3:
Interception from box culvert
Gate to avoid too much interception in rainfall



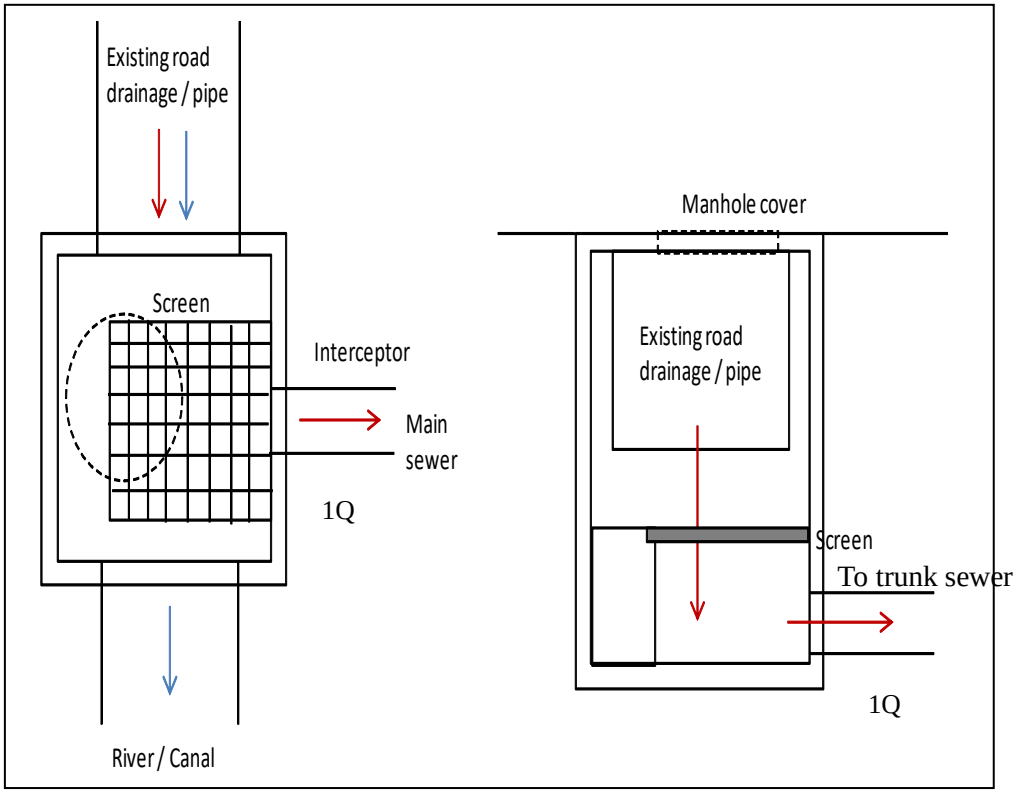
Example 4:
4 rooms manhole (most complicated case with some inlet pipe from nearby area and U-turn of sewer)
Right side room can be converted to connection to trunk sewer

Source: JICA Survey Team based on structural surveys in projects by sewerage bureau of Tokyo Metropolitan Government

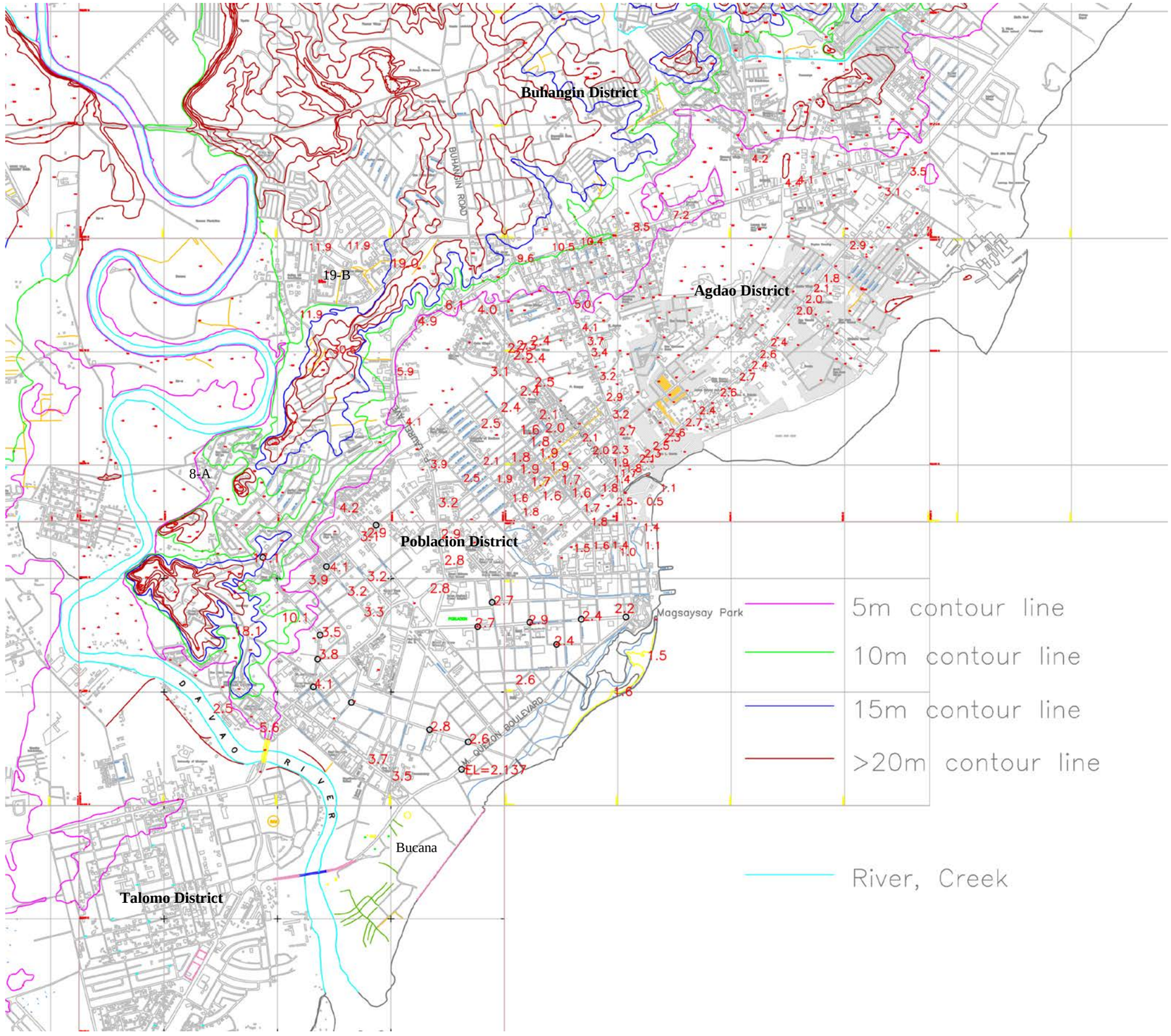
(2) Types in Metro Manila with Screen and drop wastewater

The concessionaires (particularly Maynilad) adopt the interception chamber with screen below in Metro Manila.

In case massive sand/silt/garbage flow in the drain, the screens are so easily clogged by them and function of intercepting wastewater (graywater) is interfered. Therefore, without the frequent cleaning of chambers, the sewerage function will almost stop.



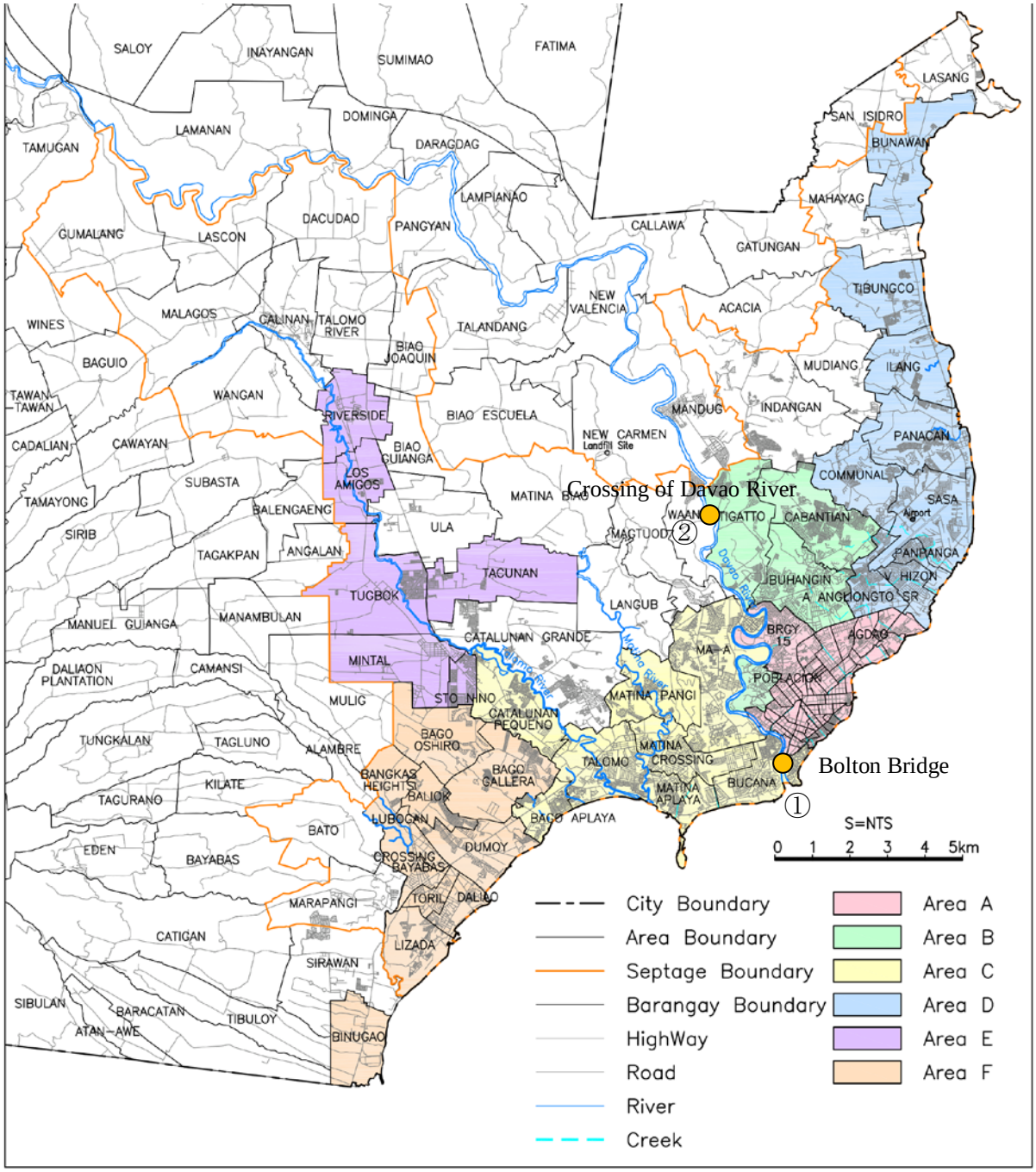
Appendix 8.1 Topographic Map in Area A



Source: JICA Survey Team based on topographic map from CPDO

APPENDIX 8.2_GEOLOGICAL DATA IN SEWERAGE DEVELOPMENT AREA

(1) Geological Information in Davao River Side



Source: JICA Survey Team

Figure A8.2.1 Locations of Past Geotechnical Survey in Davao Riverside in Sewerage Development Area

Table A8.2.1 Geological Data in Bolton Bridge near Davao Gulf (Riverside No. 1)

Table 2: BH-1 Summary of Results

Depth, m		SPT N-value	Consistency/ Compactness	USCS classification	Soil Description
From	To				
0.00	6.00	19	Medium	SP-SM	Black, Poorly Graded Sand with Silt and Gravel
6.00	9.00	24	Medium	SM	Black, Silty Sand
9.00	10.50	33	Dense	SP-SM	Black, Poorly Graded Sand with Silt

Table 3: BH-2 Summary of Results

Depth, m		SPT N-value	Consistency/ Compactness	USCS classification	Soil Description
From	To				
0.00	10.50	24	Medium	SM	Black, Silty Sand with Gravel

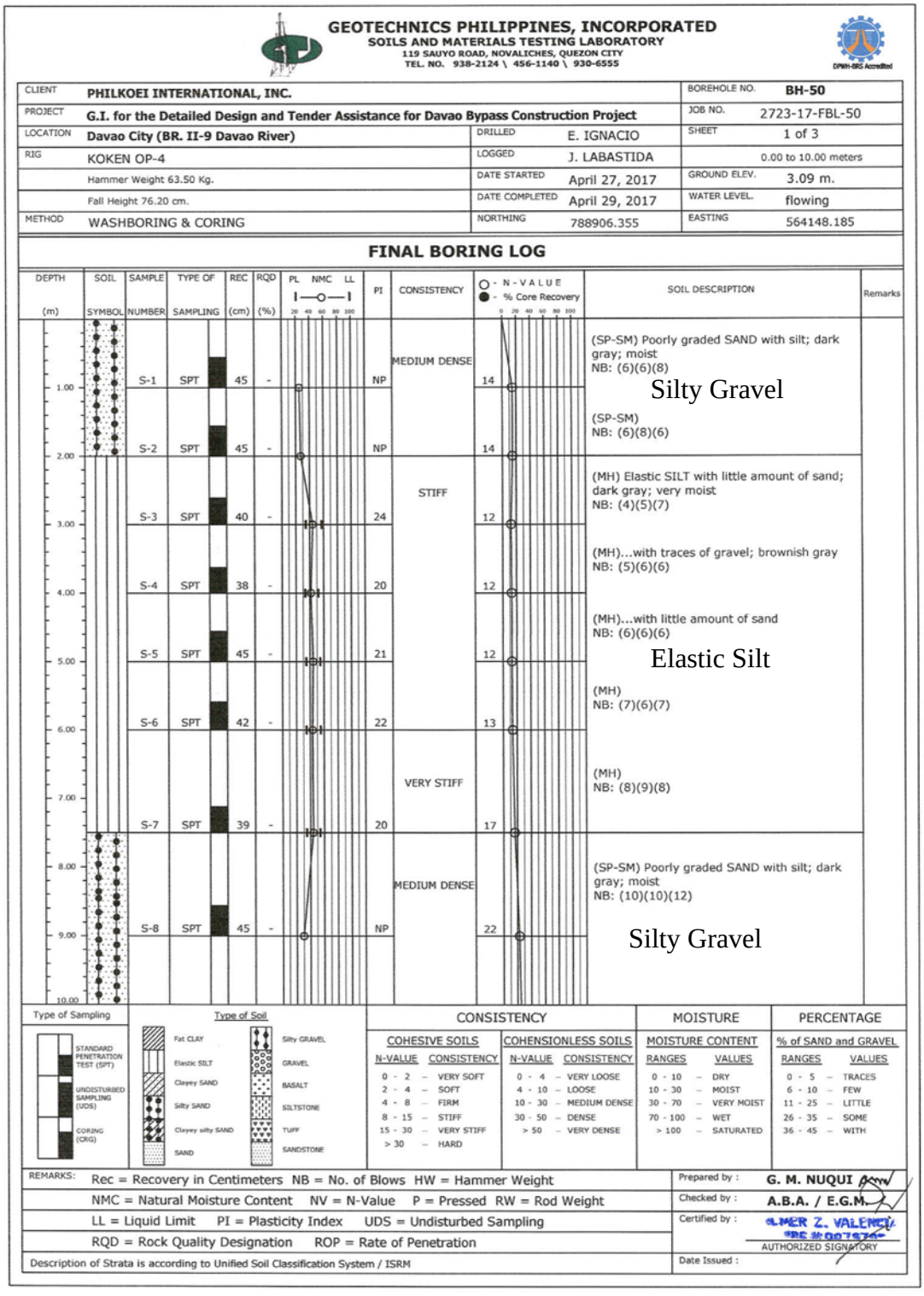
Table 4: BH-3 Summary of Results

Depth, m		SPT N-value	Consistency/ Compactness	USCS classification	Soil Description
From	To				
0.00	3.00	18	Medium	SM	Black, Silty Sand
3.00	6.00	21	Medium	SP-SM	Black, Poorly Graded Sand with Silt
6.00	10.50	30	Medium	SM	Black, Silty Sand

Table 5: BH-4 Summary of Results

Depth, m		SPT N-value	Consistency/ Compactness	USCS classification	Soil Description
From	To				
0.00	3.00	17	Medium	SM	Black, Silty Sand with Gravel
3.00	6.00	20	Medium	SP	Black, Poorly Graded Sand with Gravel
6.00	10.50	29	Medium	SM	Black, Silty Sand

Source: Davao City Engineering



GEOTECHNICS PHILIPPINES, INCORPORATED
SOILS AND MATERIALS TESTING LABORATORY
119 SAUYO ROAD, NOVALICHES, QUEZON CITY
TEL. NO. 938-2124 \ 456-1140 \ 930-6555

CLIENT	PHILKOEI INTERNATIONAL, INC.	BOREHOLE NO.	BH-50
PROJECT	G.I. for the Detailed Design and Tender Assistance for Davao Bypass Construction Project	JOB NO.	2723-17-FBL-50
LOCATION	Davao City (BR. II-9 Davao River)	DRILLED: E. IGNACIO	SHEET: 1 of 3
RIG	KOKEN OP-4	LOGGED: J. LABASTIDA	0.00 to 10.00 meters
	Hammer Weight 63.50 Kg.	DATE STARTED: April 27, 2017	GROUND ELEV.: 3.09 m.
	Fall Height 76.20 cm.	DATE COMPLETED: April 29, 2017	WATER LEVEL.: flowing
METHOD	WASHBORING & CORING	NORTHING: 788906.355	EASTING: 564148.185

FINAL BORING LOG

DEPTH (m)	SOIL SYMBOL	SAMPLE NUMBER	TYPE OF SAMPLING	REC (cm)	RQD (%)	PL NMC LL	PI	CONSISTENCY	N-VALUE / % Core Recovery	SOIL DESCRIPTION	Remarks
1.00		S-1	SPT	45	-		NP	MEDIUM DENSE	14	(SP-SM) Poorly graded SAND with silt; dark gray; moist NB: (6)(6)(8)	
										Silty Gravel	
2.00		S-2	SPT	45	-		NP		14	(SP-SM) NB: (6)(8)(6)	
3.00		S-3	SPT	40	-		24	STIFF	12	(MH) Elastic SILT with little amount of sand; dark gray; very moist NB: (4)(5)(7)	
4.00		S-4	SPT	38	-		20		12	(MH)...with traces of gravel; brownish gray NB: (5)(6)(6)	
5.00		S-5	SPT	45	-		21		12	(MH)...with little amount of sand NB: (6)(6)(6)	
										Elastic Silt	
6.00		S-6	SPT	42	-		22		13	(MH) NB: (7)(6)(7)	
7.00		S-7	SPT	39	-		20	VERY STIFF	17	(MH) NB: (8)(9)(8)	
8.00		S-8	SPT	45	-		NP	MEDIUM DENSE	22	(SP-SM) Poorly graded SAND with silt; dark gray; moist NB: (10)(10)(12)	
9.00										Silty Gravel	
10.00											

Type of Sampling: STANDARD PENETRATION TEST (SPT); UNDISTURBED SAMPLING (UDS); CORING (CRG)

Type of Soil: Fat CLAY; Elastic SILT; Clayey SAND; Silty SAND; Clayey silty SAND; SAND; Silty GRAVEL; GRAVEL; BASALT; SILTSTONE; TUFF; SANDSTONE

CONSISTENCY				MOISTURE		PERCENTAGE	
COHESIVE SOILS		COHENSIONLESS SOILS		MOISTURE CONTENT		% of SAND and GRAVEL	
N-VALUE	CONSISTENCY	N-VALUE	CONSISTENCY	RANGES	VALUES	RANGES	VALUES
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	0 - 10	DRY	0 - 5	TRACES
2 - 4	SOFT	4 - 10	LOOSE	10 - 30	MOIST	6 - 10	FEW
4 - 8	FIRM	10 - 30	MEDIUM DENSE	30 - 70	VERY MOIST	11 - 25	LITTLE
8 - 15	STIFF	30 - 50	DENSE	70 - 100	WET	26 - 35	SOME
15 - 30	VERY STIFF	> 50	VERY DENSE	> 100	SATURATED	36 - 45	WITH
> 30	HARD						

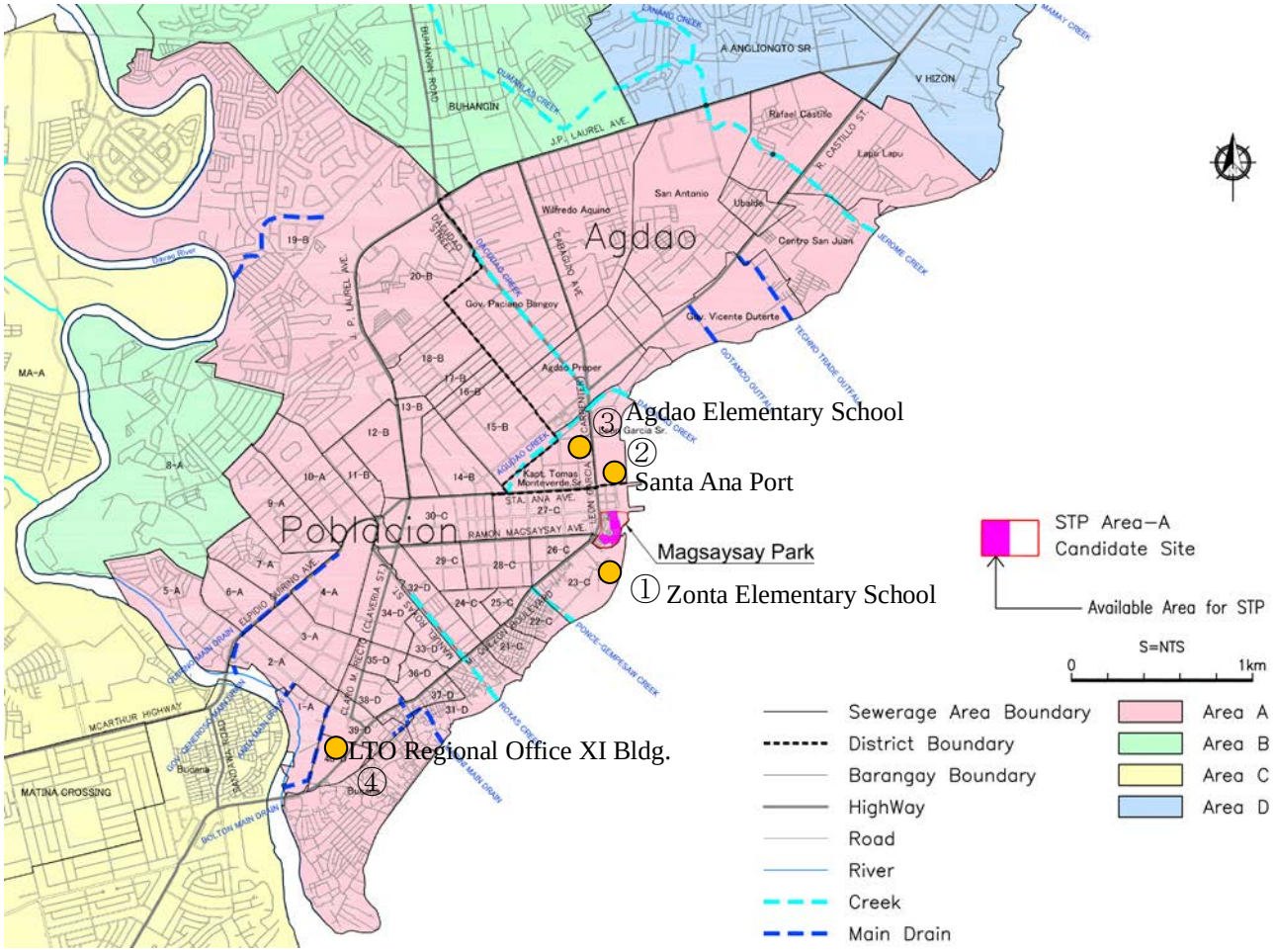
REMARKS: Rec = Recovery in Centimeters NB = No. of Blows HW = Hammer Weight
NMC = Natural Moisture Content NV = N-Value P = Pressed RW = Rod Weight
LL = Liquid Limit PI = Plasticity Index UDS = Undisturbed Sampling
RQD = Rock Quality Designation ROP = Rate of Penetration
Description of Strata is according to Unified Soil Classification System / ISRM

Prepared by : G. M. NUQUI
Checked by : A.B.A. / E.G.M.
Certified by : ELMER Z. VALENCIA
AUTHORIZED SIGNATORY
Date Issued :

Source: Geotechnical Investigation Report in Davao Bypass Road Project

Figure A8.2.2 Bore Hole Log at Crossing of Future Bypass Road and Davao River (Riverside No. 2)

(2) Geological Information in Davao Gulf Side



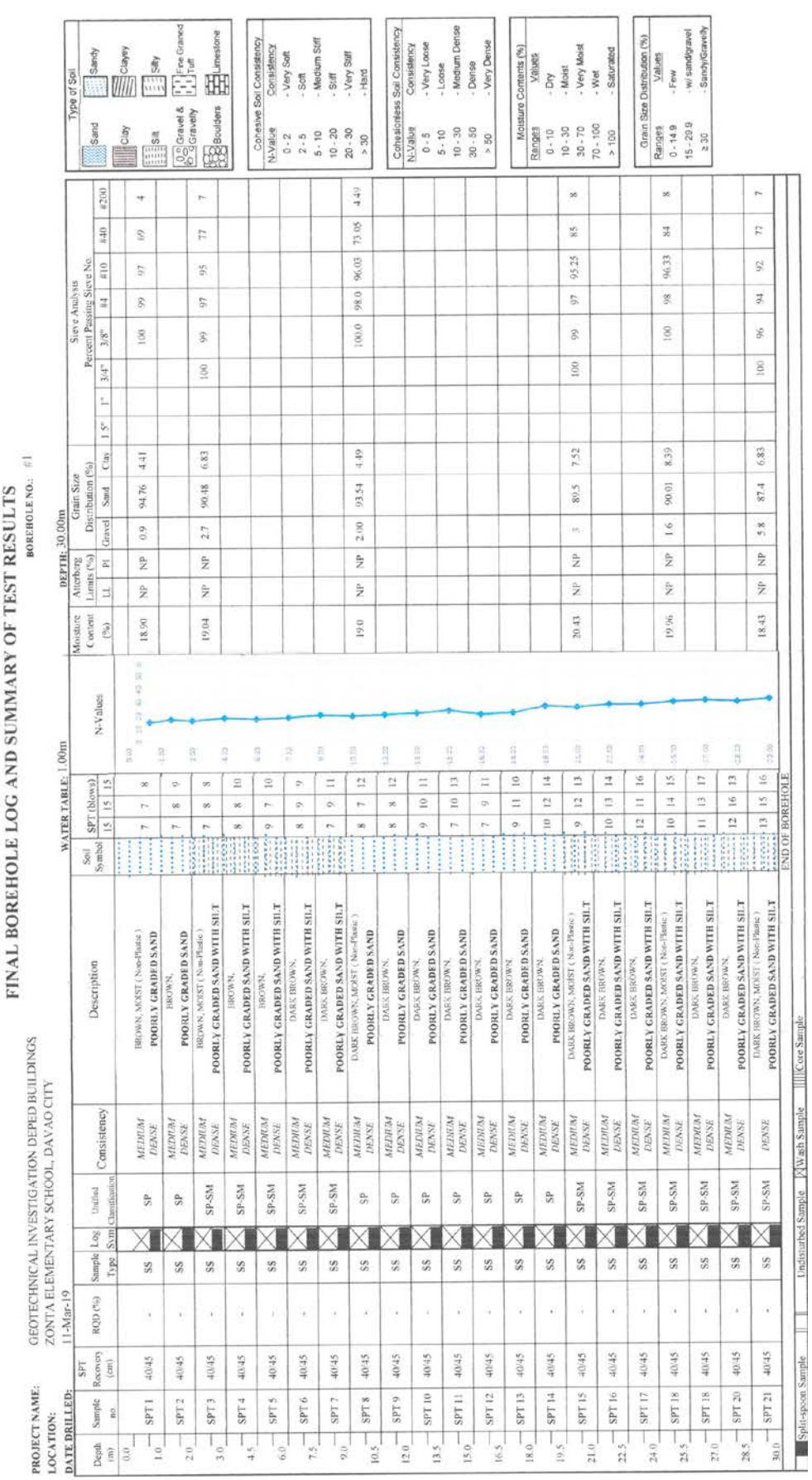
Source: JICA Survey Team

Figure A8.2.3 Locations of Past Geotechnical Survey in Davao Gulf Side in Sewerage Development Area

Table A8.2.2 Summary of Soil Condition in Seaside Area in Poblacion and Agdao

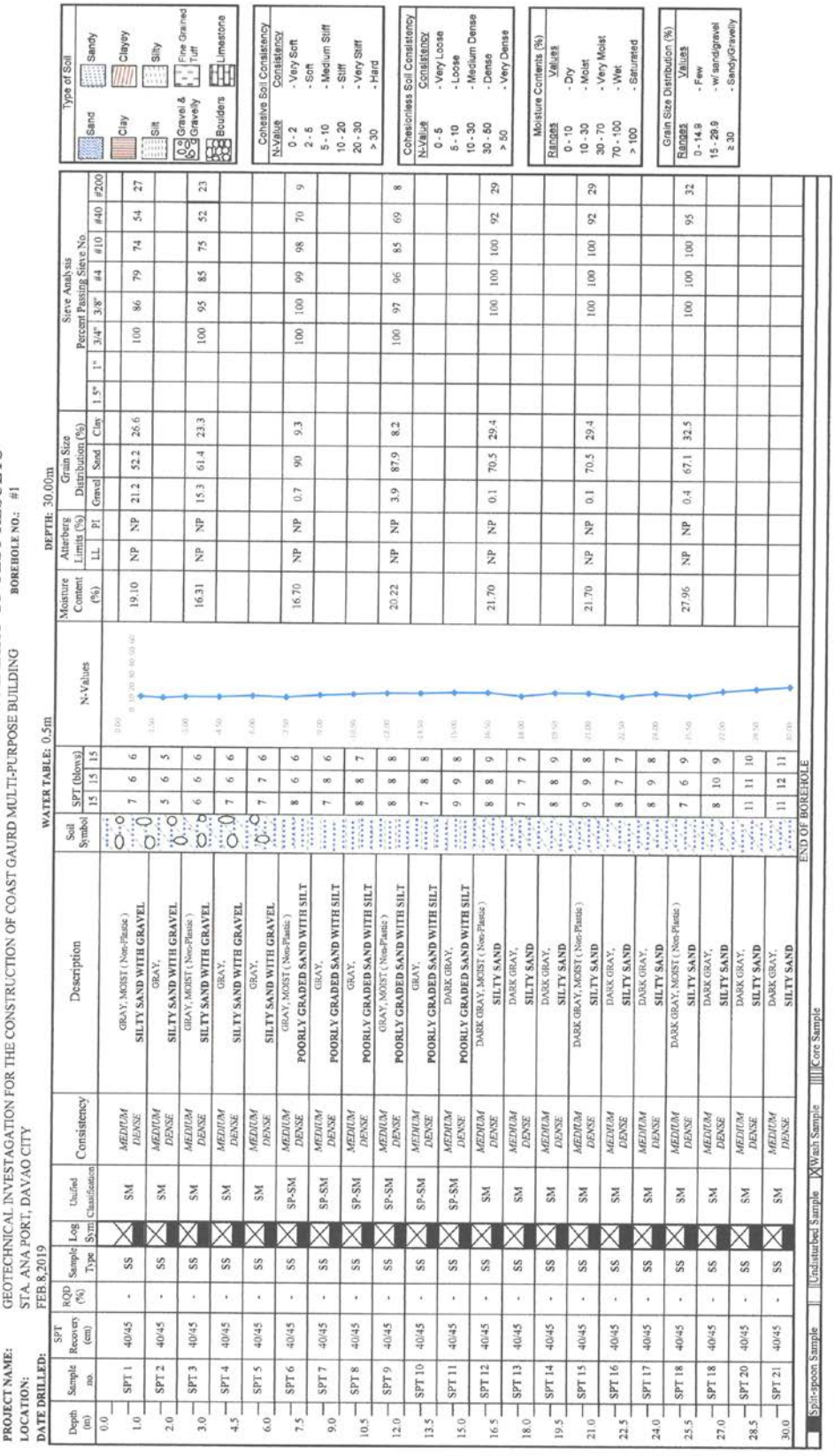
Depth (m)	Zonta Elementary		Santa Ana Port		Agdao Elementary		LTO Regional	
	SPT N-Value	Soil Type	SPT N-Value	Soil Type	SPT N-Value	Soil Type	SPT N-Value	Soil Type
0-3	15-17	SP	11-12	SM	12-20	SM	12-13	SM, ML
3-6	17-18	SP-SM	12-13	SM	21-24	SP-SM	17-18	SM
6-9	18-20	SP-SM	12-14	SP-SM	21-26	SP-SM	20-21	SM
9-12	19-20	SM	15-16	SP-SM	26-30	SP	21	SM
12-15	20-23	SM	16-17	SP-SM	27-31	SP	22	SM
15-18	20-21	SM	14-17	SM	27-31	SP-SM	18-25	SM
18-21	25-26	SM	17	SM	28-32	SP	18-20	SM

Note: SP: Poorly Graded Sand, SP-SM: Poorly Graded Sand with Silt, SM: Silty Sand, ML: Silt with Sand
Source: JICA Survey Team based on DPWH boring data



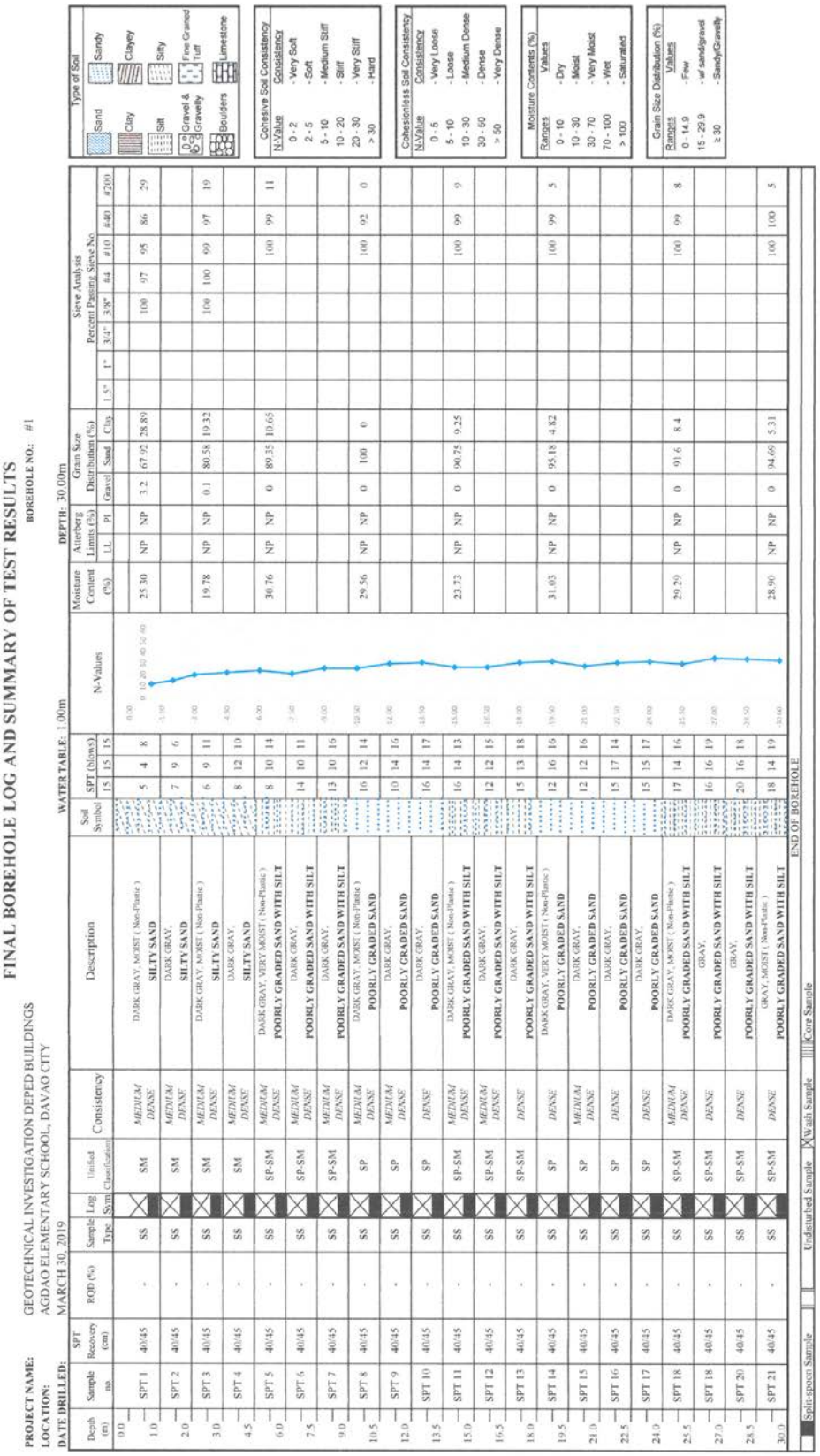
Source: DPWH Davao City 1st District Engineering Office

Figure A8.2.4 Bore Hole Log at Zonta Elementary School in Barangay 23-C (Seaside No. 1)



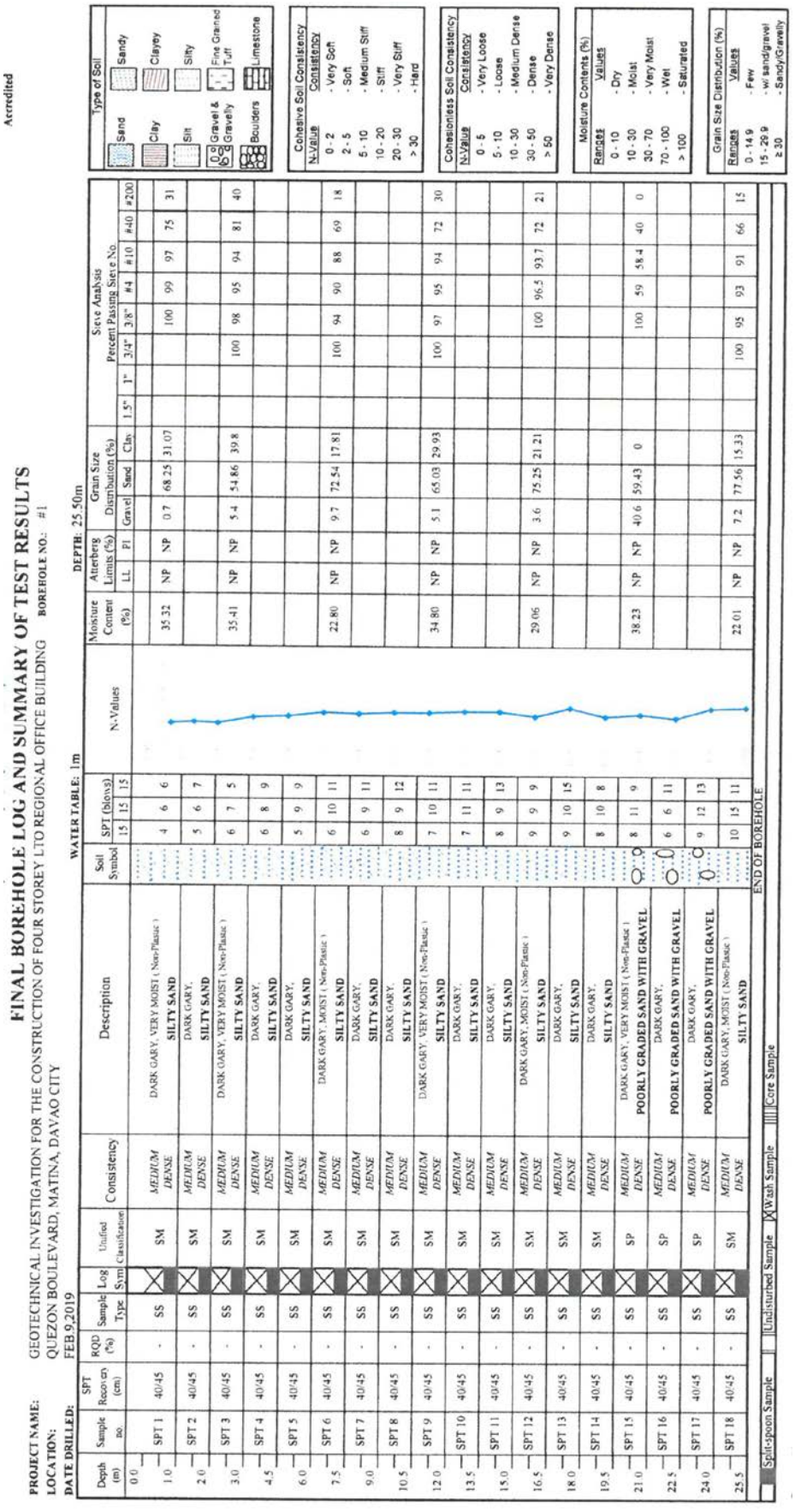
Source: DPWH Davao City 1st District Engineering Office

Figure A8.2.5 Bore Hole Log at Santa Ana Port in Barangay Leon Garcia (Seaside No. 2)



Source: DPWH Davao City 1st District Engineering Office

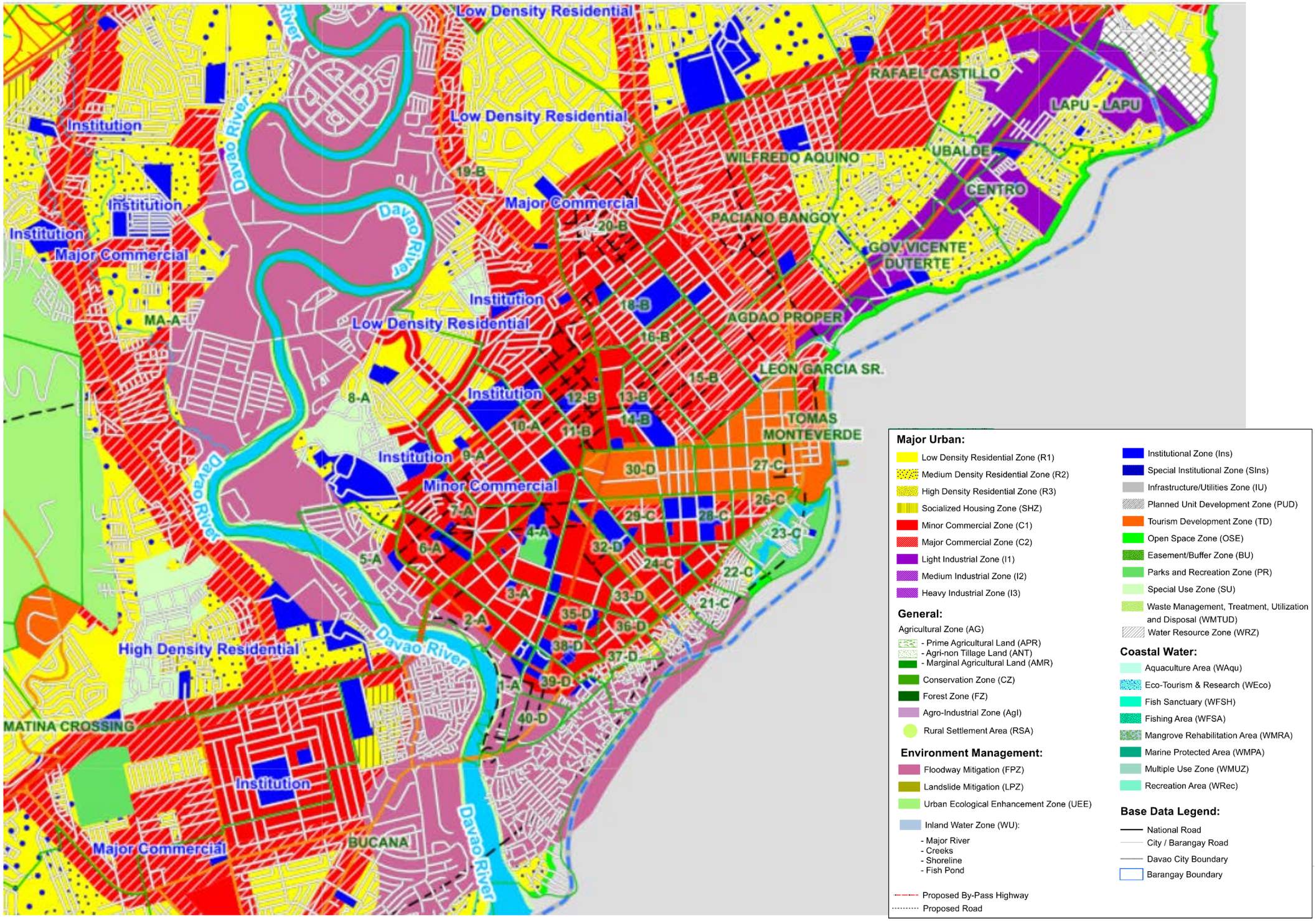
Figure A8.2.6 Bore Hole Log at Agdao Elementary School in Barangay Tomas Monteverde (Seaside No. 3)



Source: DPWH Davao City 1st District Engineering Office

Figure A8.2.7 Bore Hole Log at LTO Regional Office XI Building in Barangay 40-D (Seaside No. 4)

Appendix 8.3 Land Use (Zoning) Plan in Area A

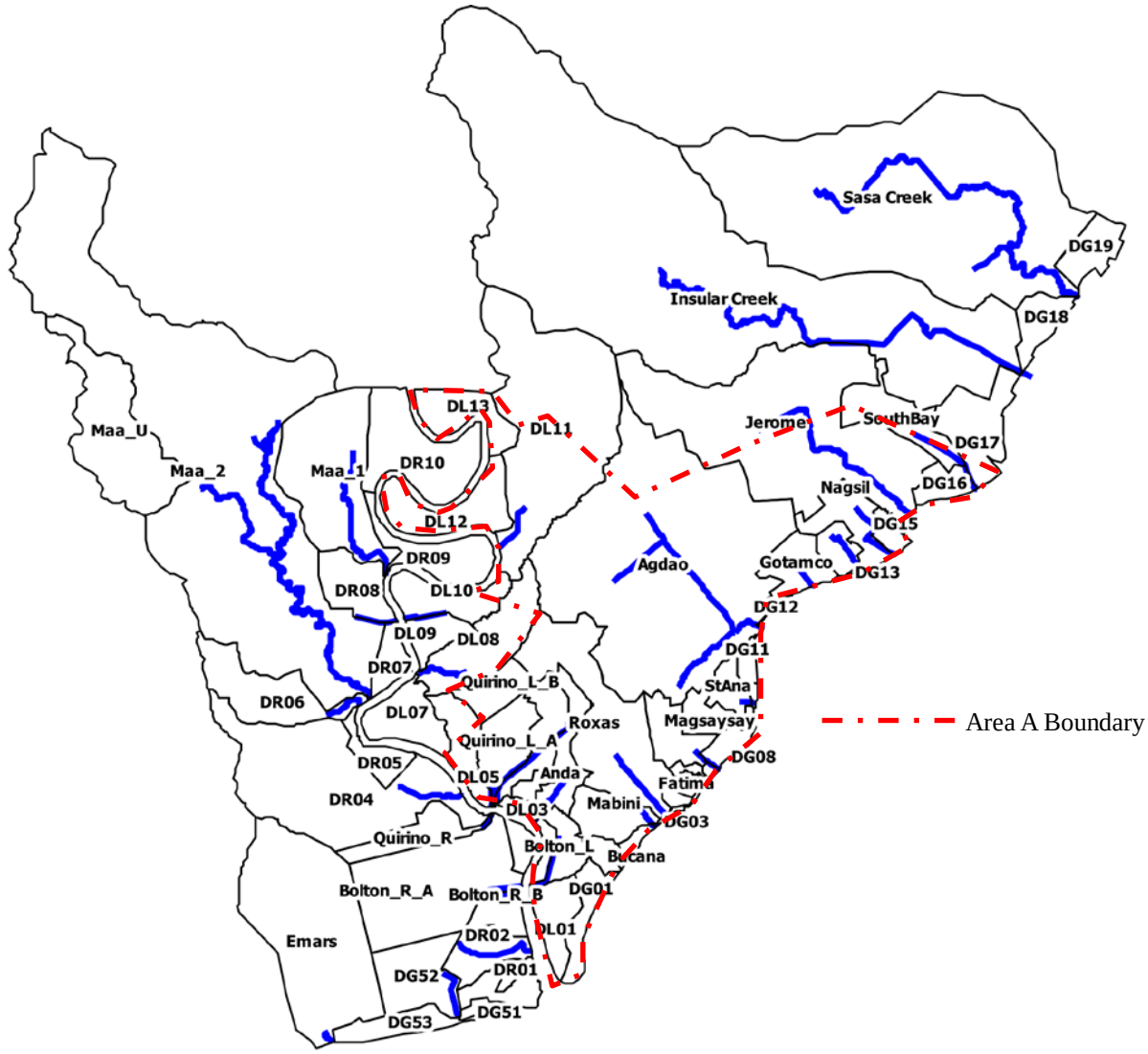


Source: CPDO

APPENDIX 8.4_RUNOFF COEFFICIENT IN SEWERAGE DEVELOPMENT AREA

(1) Stormwater Drainage Area

The JICA Flood Control M/P Team organized the stormwater drainage area based on various data such as drainage inventory, topographic condition, and road network as shown in Figure A8.4.1.



Source: JICA Survey Team based on drainage area by Flood Control M/P Team

Figure A8.4.1 Stormwater Drainage Area in comparison with Sewerage Area A

(2) Stormwater Drainage Area

The runoff coefficients in each drainage area are shown in Table A8.4.1. The maximum value is 0.80 in Pelayo Drainage Area near Davao River and the minimum is 0.32 in DG09 near Davao Gulf. The average based on area (hectare) is 0.65.

Table A8.4.1 Runoff Coefficient in Drainage Areas related to Sewerage Area A

SN	Name	Flow To	Area A Area (ha)	Average slope (%)	Percent of urban type land use (%)	RC
1	**Bucana**	Davao Gulf	9.81	0.192	99.9	0.62
2	**Mabini**	Davao Gulf	35.61	0.171	88.5	0.68
3	**Roxas**	Davao Gulf	139.19	0.602	86.4	0.71
4	**Jacinto**	Davao Gulf	4.71	0.203	97.9	0.63
5	**Fatima**	Davao Gulf	5.23	0.314	99.0	0.62
6	**Suzao**	Davao Gulf	3.68	0.285	99.0	0.66
7	**Ponce**	Davao Gulf	32.01	0.121	77.9	0.71
8	**Magsaysay**	Davao Gulf	18.87	0.261	99.9	0.74
9	**StAna**	Davao Gulf	18.53	0.461	91.6	0.75
10	**Agdao**	Davao Gulf	514.46	1.606	87.8	0.69
11	**Gotamco**	Davao Gulf	33.51	0.229	95.1	0.70
12	**Technotrade**	Davao Gulf	17.96	0.169	97.2	0.72
13	**Nagsil**	Davao Gulf	40.35	0.144	97.2	0.65
14	**Jerome**	Davao Gulf	339.26	2.361	83.4	0.62
15	**SouthBay**	Davao Gulf	48.82	1.766	99.0	0.74
18	DG01	Davao Gulf	27.12	0.394	99.8	0.61
19	DG02	Davao Gulf	7.38	0.654	99.4	0.61
20	DG03	Davao Gulf	0.48	0.683	100.0	0.60
21	DG04	Davao Gulf	1.13	0.682	100.0	0.61
22	DG05	Davao Gulf	0.74	1.260	100.0	0.60
23	DG06	Davao Gulf	1.09	0.675	100.0	0.60
24	DG07	Davao Gulf	1.68	0.359	96.8	0.63
25	DG08	Davao Gulf	14.47	0.174	98.1	0.62
26	DG09	Davao Gulf	1.80	0.415	12.7	0.32
27	DG10	Davao Gulf	1.84	1.053	74.3	0.72
28	DG11	Davao Gulf	7.83	0.721	66.8	0.50
29	DG12	Davao Gulf	2.06	0.278	100.0	0.61
30	DG13	Davao Gulf	0.72	0.324	100.0	0.60
31	DG14	Davao Gulf	7.93	0.589	100.0	0.79
32	DG15	Davao Gulf	4.68	0.368	100.0	0.62
33	DG16	Davao Gulf	18.77	0.467	89.3	0.61
41	**Bolton_L**	Davao River	23.52	0.396	81.8	0.72
42	**Anda**	Davao River	37.70	0.279	85.1	0.71
43	**Pelayo**	Davao RIver	8.42	0.496	97.5	0.80
44	**Quirino_L_A**	Davao RIver	42.30	2.432	88.0	0.69
45	**Quirino_L_B**	Davao RIver	63.69	2.253	78.8	0.65
46	DL01	Davao River	33.15	0.298	98.2	0.63
47	DL02	Davao River	8.85	0.886	79.8	0.64
48	DL03	Davao River	1.41	1.096	99.9	0.73
49	DL04	Davao River	2.56	1.243	100.0	0.65
50	DL05	Davao River	5.57	2.259	98.5	0.63
51	DL06	Davao River	28.84	7.209	64.2	0.58
52	DL07	Davao River	42.41	8.101	75.0	0.54
53	**DL08**	Davao River	72.38	6.423	69.1	0.54
54	DL09	Davao River	22.49	5.397	84.7	0.56
55	**DL10**	Davao River	40.71	3.909	70.2	0.59
56	**DL11**	Davao River	259.10	5.288	99.0	0.66
57	DL12	Davao River	56.55	2.271	37.8	0.42
58	DL13	Davao River	39.83	5.397	70.5	0.54
			2151.21		Max	0.80
					Ave.	0.65
					Min	0.32

Source: JICA Survey Team based on data from Flood Control M/P Team

APPENDIX 8.5_STUDY ON APPLICABLE JAPANESE SEWERAGE TECHNOLOGIES FOR DAVAO CITY

1. Overview of Japanese Sewerage Technologies

Based on the preliminary organization of various sewerage technologies with interview to Japanese companies, the applicable treatment process and sewerage technologies in the survey area are summarized in Table 1.1.

Table 1.1 Sewerage Technology to be Applicable in the Survey Area

Issue	Effective technologies	Applicable sewerage technologies
1. Pipeline		
➢ The rapid sewerage system development is required considering the sewerage coverage is currently 0%. ➢ Difficulty to install pipes by open-cut method in the urban area	➢ Non-open cut method with less impact to residential (pipe jacking method and shield tunneling method)	(1) Pipe jacking method (Long distance and curved jacking) (2) Pipe jacking method (house connection) (3) Open piping
2. Wastewater Treatment Facility (WTF)		
➢ Limitation of STP site ➢ Shortage of larger sized site ➢ Shortage of O&M staff ➢ Response to the strict effluent standard (Advanced treatment) ➢ High electricity cost	➢ Compact treatment system with simple operation and maintenance ➢ Applicable technologies for advanced treatment ➢ Energy-saving treatment process/equipment	(1) (Deep type) Conventional activated sludge process (CAS) (2) Sequencing Batch Reactor (SBR) (3) Pre-treated Trickling Filtration method (PTF)* (4) Membrane Separation Bioreactor (MBR method) (5) Integrated Fixed-Film Activated Sludge (IFAS/MBBR) (6) Other equipment (Energy-saving blower/diffuser)
3. Sludge Treatment Facility (STF)		
➢ Shortage of the sludge disposal site ➢ Leakage of untreated sludge from septic tanks	➢ Technologies for reduction of sludge volume and recycle	(7) Energy-saving dehydrator (8) Mechanical dryer (9) Recycle technology (Composting technology, digestion gas power generator, utilization of construction material)
(10) Operation and Maintenance		
➢ Blockage of pipes and failure of pumps due to inflow of sands and garbage to combined sewerage system ➢ Discharge of debris to the public water area ➢ Shortage of O&M staffs ➢ Measure for high tide in WWTP	➢ Technology for automating O&M ➢ Asset management technology for database of sewerage facilities information aimed at efficient operation ➢ Pump gate for forced drainage of treated water	(1) Auto flushing device for sewer (Flash Gate) (2) Vortex flow type water surface control device (3) SCADA system (4) Asset management system (5) Sewer optical fiber network system (6) Pump gate

Source: JICA Survey Team

In section 2 to 5, the general descriptions of the applicable technologies, which are listed in Table 1.1, are explained.

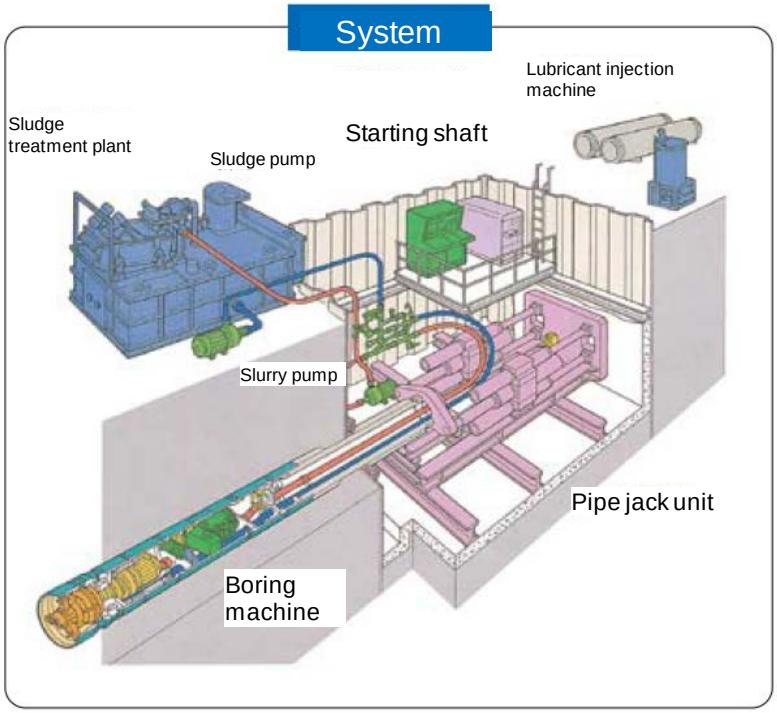
SBR and PTF methods in WTF are introduced in 5.3 but those shall be out of options in this study. Details are described in comparison of treatment processes in Chapter 6.

2. Sewer

(1) Long-distance Pipe-jacking Method

The main pipelines will be constructed under the main busy streets in the central business district. The occupation of the large-scale roads, which open cut method cannot avoid, causes heavy traffic congestion, and also the construction noise, dust and vibration. Therefore, the pipe jacking method would be good solution to apply to the pipe installation.

The overview of pipe jacking system is shown in the following figure. Road occupation is only required around the starting and arrival shaft. This construction method contributes to not only avoiding heavy traffic congestion but also reducing the waste generated in construction works.



Source: Manufacturer's brochure

Figure 2.1 Overview of Sewer Installation by Pipe-jacking Method

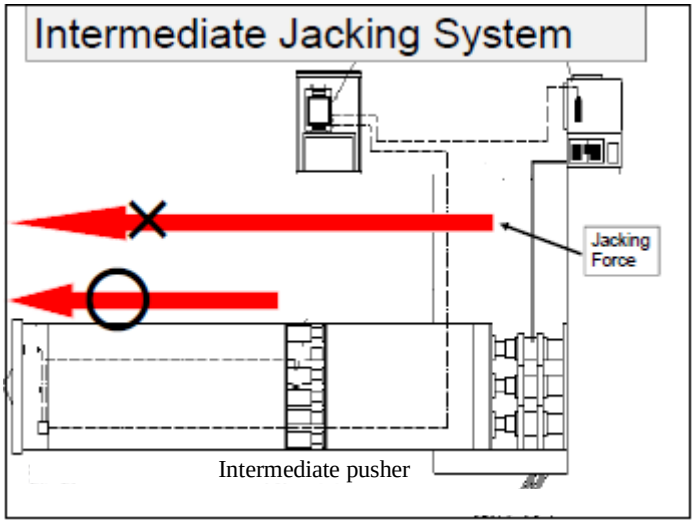
One of the key factors to minimize adverse influences and risks caused by the pipe installation construction as mentioned above is reducing the number of shafts. Installing the intermediate pusher in the middle of pipes as shown in the figure below will make it possible. This method is called long-distance pipe-jacking method which Japan has expertise. One span can be the hundreds of meters (more than 500m in maximum), and it is able to be jacked by a propulsion force provided the intermediate pusher. This technology enables the number of shafts to be possibly reduced half, moreover the construction cost can be saved because construction period is shortened as a result compared with the ordinal pipe-jacking method.

However, this method requires technologies which Japan has sufficient successful experiences as

described below.

Lubrication is used to push a pipe without damage, which has to appropriately be applied to the surface of a pipe. As countermeasure against it, automated lubricant injection system is installed to effectively control injection amount, points and time.

Also, propulsion at a curve is possible by using curve formulation unit and gyrocompass attached to boring machine.



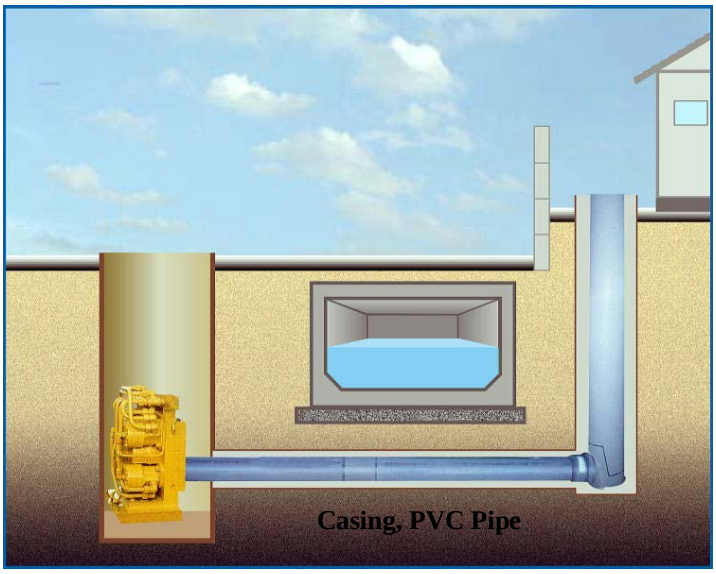
Source: Manufacturer's presentation material

Figure 2.2 Image of Intermediate Pusher of Long-distance Pipe-jacking Method

(2) Pipe-jacking Method for House Connections

The individual connections to buildings are quite difficult or time-consuming when crossing the large utility such as box culverts. The pipe-jacking method for house connection has been prevailed in Japan and it can be conducted by many small scale local contractors. PVC pipe is installed with the casing pipe for jacking in the soil (see Figure 2.3 for the image).

Since there are many large scale box culverts for drainage and house connections shall be done with crossing such structures, this pipe jacking method will become useful in future to accelerate the sewerage work and avoid any damage to existing utilities.



Source: Japanese local contractors' website

Figure 2.3 Image of Small Scale Pipe Jacking for House Connection

Constructing vertical shaft for pipe jacking beside open drain

Constructing inlet chamber for sewage (house side)

Small scale pipe jacking machine

Jacking casing pipe from the vertical shaft

Source: Japanese local contractors' website

Figure 2.4 Photos of Small Scale Pipe Jacking for House Connection

(3) Open Piping for Quick Sewer Development

Normally the sewer pipe should be installed under the ground. However, there are trials of open piping in new sewerage development area in Japan for quick and reasonable development. The trials are seen in rural cities where the sewer development has been delayed in Japan but the method can be applied to Davao of highly congested area which lead to be difficult to lay lateral pipes under the ground. In case the relocations of houses beside sea/river/channels are difficult due to legal right of residence and there is space to put the open piping beside the houses, this method can be considered. It can be also effective when the houses to collect the wastewater is much lower than the lateral sewers under nearby road.

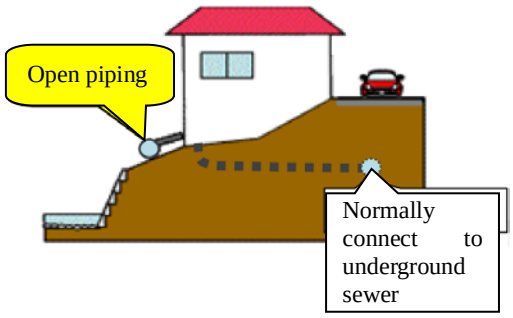
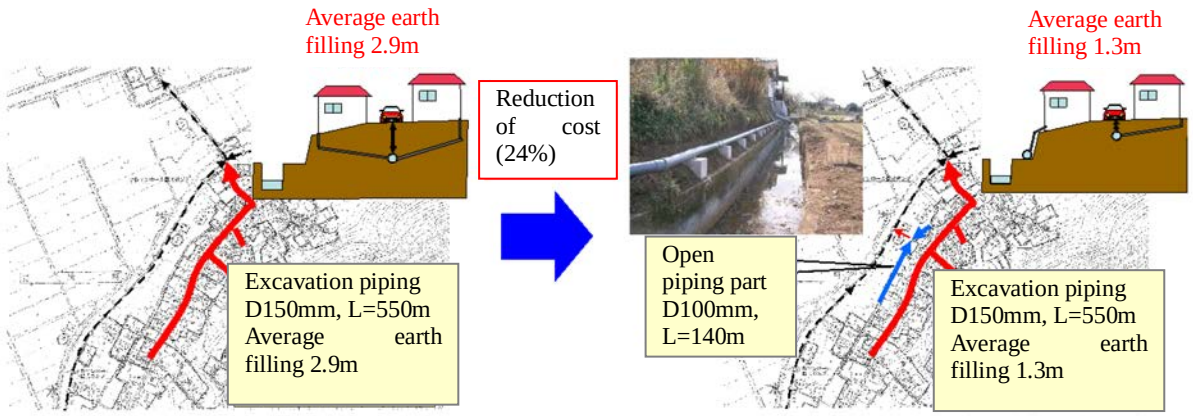


Image of Open Piping

Example of open piping beside road/bridge



Source: Quick sewerage project under Ministry of Land, Infrastructure and Transportation

Figure 2.5 Comparison between Ordinal Method and Open Piping

3. Wastewater Treatment Facility (WTF)

3.1 Applicable Treatment Process

(1) (Deep type) Conventional Activated Sludge Process (CAS method)

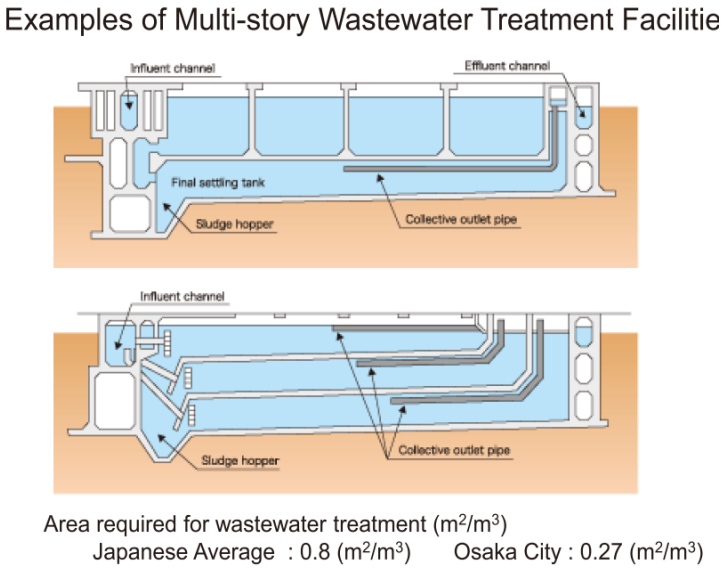
Since available space is limited at the existing treatment plants and site acquisition which takes time should be avoided as much as possible, the facilities have been constructed utilizing various kinds of lands.

Therefore, one treatment plant is constructed above a retention pond and another treatment plant has all its water tanks in the underground with the administrative building on top of them.

Source : Excerpt from MWSS presentation materials

Figure 3.1 Treatment Plant Established Utilizing Space above a Retention Pond

The deep type conventional activated sludge process, which uses a multi-layered sedimentation tank and a deep layer reactor, is a method which has been developed and adopted in Osaka in 1960's and it has been implemented already in the western part of Manila metropolitan area by a Japanese company and enjoyed a high evaluation.



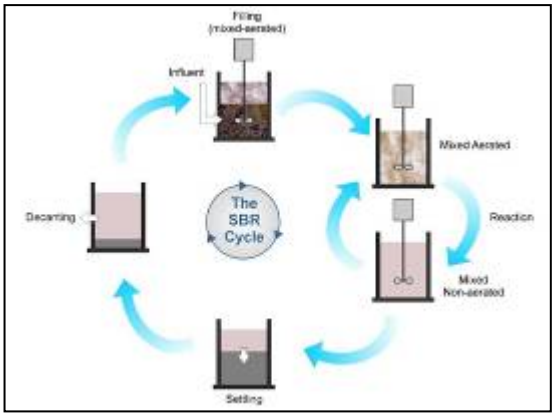
Source : Excerpt from MLIT and UAE infrastructure seminar materials

Figure 3.2 Image of Deep Type CAS Method

And for further advanced treatment which is expected in the future, extra space for the future expansion shall be secured when a treatment plant is constructed.

(2) Sequencing Batch Reactor (SBR)

SBR is considered a fill-and-draw activated sludge system. The processes of equalization, aeration, and clarification are all achieved in the same tank, unlike a conventional activated sludge system, in which the same processes are accomplished in separate tanks. Wastewater is added to the tank, treated to remove undesirable components, and then discharged. As shown in Figure 5.3.3, an SBR system consists of five common steps carried out in sequence: 1) fill, 2) react (aeration), 3) settle (sedimentation/clarification), 4) draw (the effluent is decanted), and 5) idle.



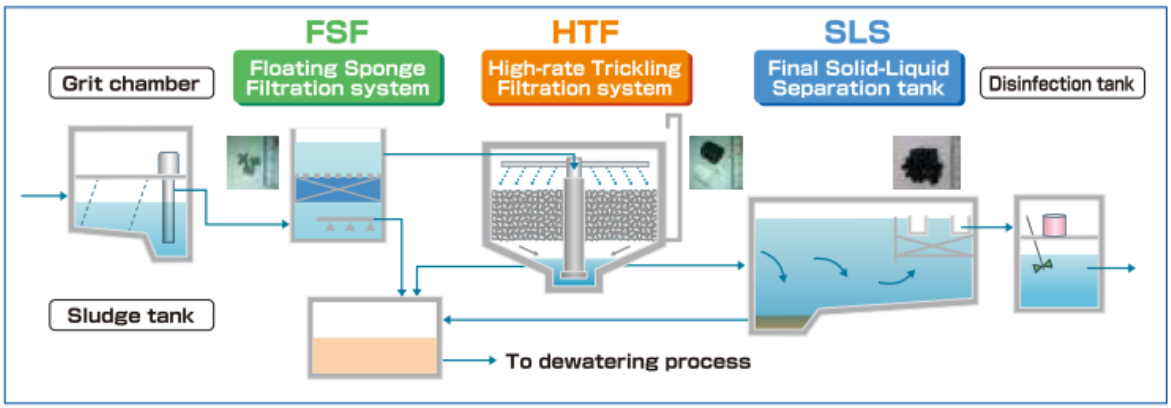
Source: JICA Study Team

Figure 3.3 SBR Process Cycle

Sludge wasting usually occurs during the settling phase. The SBR acts as an equalization basin when filled with wastewater, enabling the system to tolerate peak flows or loads. After passing through a screen to remove grit, the effluent enters a partially filled reactor. Once the reactor is full, it performs like a conventional activated sludge system without continuous influent or effluent flow. Aeration and mixing are discontinued after the biological reactions are complete, the solids are allowed to settle, and the treated effluent (supernatant) is removed. Excess solids are removed at any time during the cycle. Due to their relatively small footprints, these are useful in areas where available land is limited. In addition, it is easy to modify cycles within the system for nutrient and phosphorus removal, if necessary.

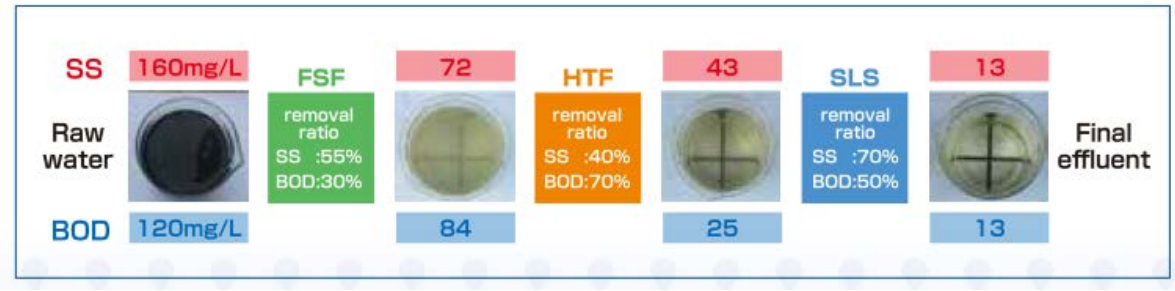
(3) Pre-treated Trickling Filtration Method (PTF method)

The PTF method is a treatment method developed for ASEAN nations and has the advantage that the power consumption is lower compared to the conventional methods.



Source: :Manufacture's brochure

Figure 3.4 Process Flow of PTF Method



Source : Manufacturer's brochure

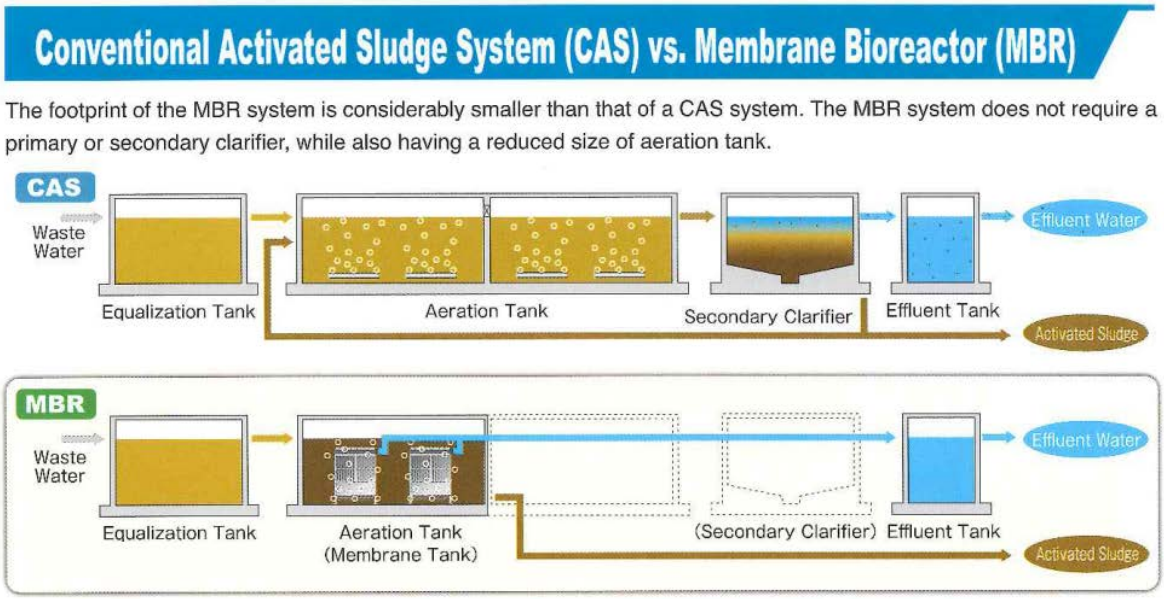
Figure 3.5 Effluent Quality of PTF Method

Considering the limited construction sites and high power cost in the target area, this method can be a very effective technology because the facility with this method will be compact and can save power consumption. However, this technology cannot support advanced treatment (removal of nitrogen and phosphorus), which means that this is not applicable to the existing effluent regulation, DAO-08.

Therefore, this treatment method shall be out of the options for the study. It is also mentioned in Chapter 7 as a comparison of treatment processes.

(4) Membrane Bio Reactor (MBR method)

Membrane Bio Reactor (MBR) method is the most applicable technology as the wastewater treatment because of the space limitation. MBR system does not require the primary and final sedimentation tanks, while having a reduced size of reactor which has membranes (see Figure 5.3.6). It makes it possible to operate MBR processes at higher MLSS compared to conventional activated sludge process, therefore, reactor capacity can be reduced.

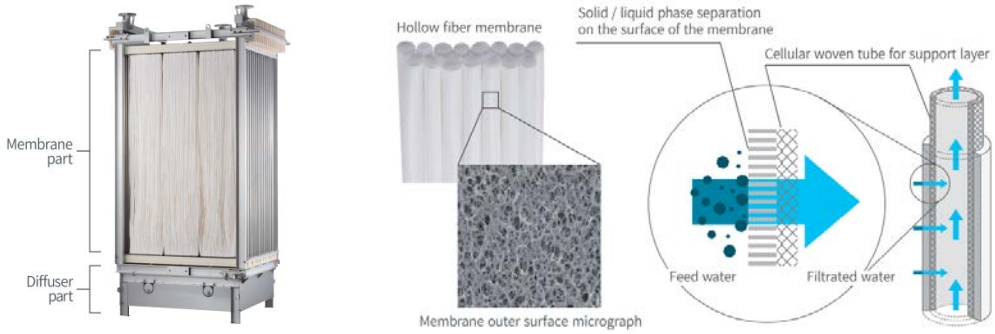


Source : Manufacturer's brochure

Figure 3.6 Image of MBR Method Application

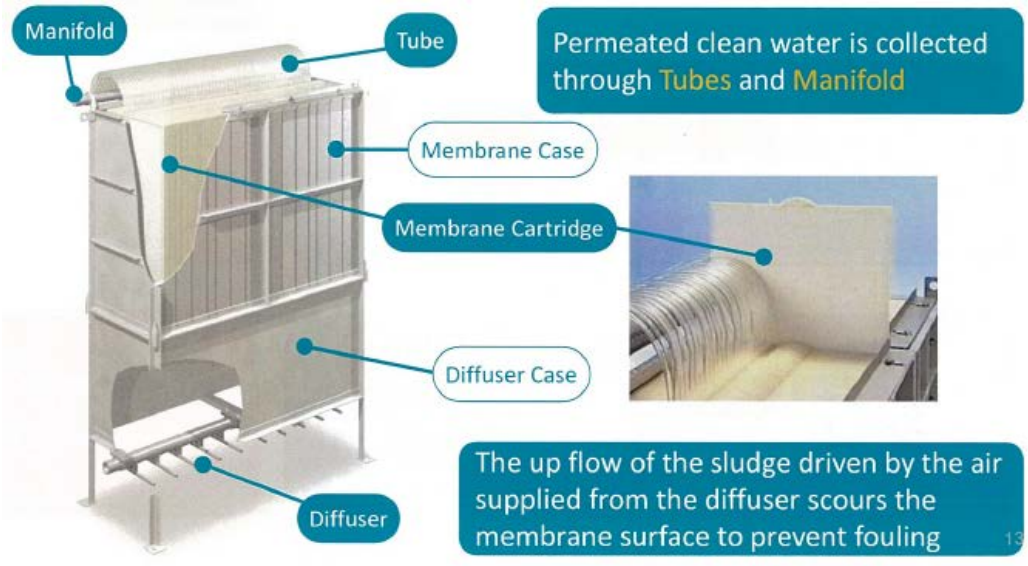
It is also possible not to install a disinfection facility theoretically because coliform bacillus cannot pass through a membrane, but it is usually installed for emergency purposes such as power failure.

Japan is strong on the market of membrane, and accounts for about 40% share in the international market of membranes used for the MBR method (as of 2009) because of its high quality. Also, after the sales service provided by manufacture is important factor as selection criteria since MBR is composed of a lot of mechanical and electric equipment that need maintenance. For example, membrane requires cleaning for the removal of fouling about once every one to two years per unit, that is, after sales service is crucial and it is even better that a brunch of manufacture that has sufficient experiences is located in the same country for the prompt action.



Source: Manufacturer's presentation material

Figure 3.7 Overview of Hollow Fiber Membrane Unit

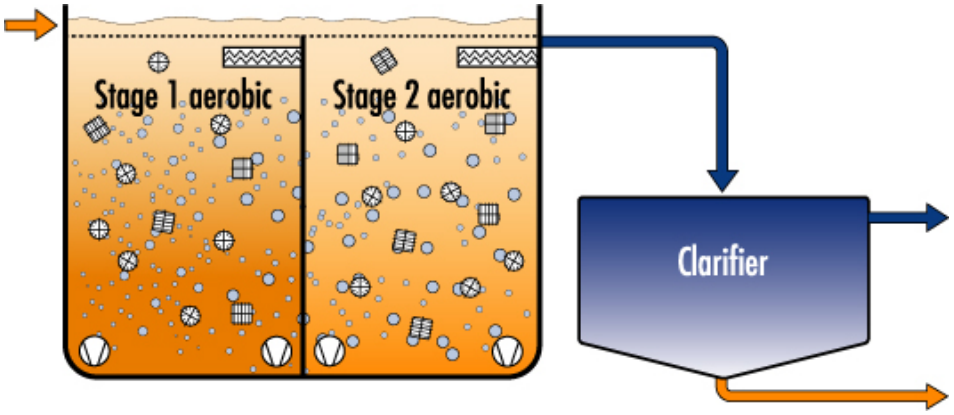


Source: Manufacturer's presentation material

Figure 3.8 Overview of Flat Sheet Membrane Unit

(5) Integrated Fixed-Film Activated Sludge (IFAS)/Moving Bed Biofilm Reactor (MBBR)

IFAS systems (MBBR system as one of IFAS systems) are based on reactors that are filled with plastic medias to provide a surface that is colonized by bacteria that grow into a biofilm. The reactors can be operated under aerobic conditions for BOD removal and nitrification or under anoxic conditions for denitrification. During operation, the medias are kept in constant circulation. In an aerobic reactor, circulation is induced through the action of air bubbles injected into the tank by a coarse bubble diffuser system. In an anoxic reactor, a submerged mixer is typically supplied. The medias can occupy up to 70% of the reactor volume on a bulk volume basis. Experience has shown that mixing efficiency decreases at higher percentage fills. Figure 5.3.9 shows a typical image of IFAS layout.



Source : Manufacturer's brochure

Figure 3.9 Image of IFAS Method

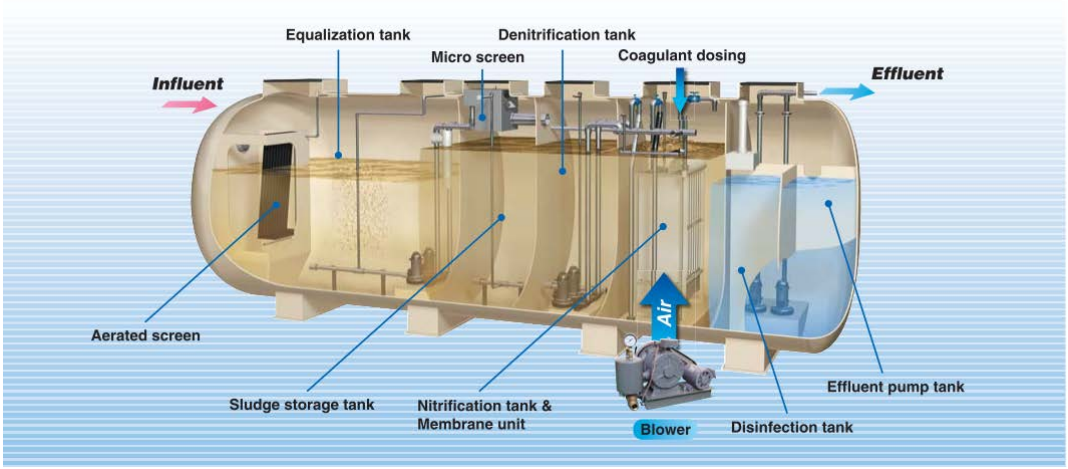
(6) Johkaso Technology for On-site Treatment Area

The on-site treatment for communities is effective and reasonable in suburb and particularly hilly areas to avoid the installation of too long pipelines and pumping stations to convey wastewater to the sole treatment plant in the large sewerage area. Johkaso technology is useful for the on-site treatment, and the installation and O&M works are easy with the compact unit. After many experiences of installing Johkaso for a long time in Japan, the technologies were improved and the biological nutrient removal (BNR) to remove nitrogen and phosphorus can be achieved with some types. Figure 3.10 shows an image of BNR type Johkaso and Table 5.3.1 shows example of influent and effluent water qualities. Depending on the discharged water body and the influent water quality, simpler type to treat BOD and nitrogen, or only BOD can be selected and the system gets simpler and more reasonable. In case of 200 m^3/day unit, wastewater generated from 1,000 persons can be treated. .

Table 3.1 Example of Influent and Effluent Water Qualities in Johkaso (BNR Type)

Parameter	Influent	Effluent
BOD (mg/L)	50-450	≦5
COD (mg/L)	100	≦10
T-N (mg/L)	50-100	≦10
T-P (mg/L)	5	≦ 1

Source : Manufacturer's brochure



Source : Manufacturer's brochure

Figure 3.10 Image of Johkaso Unit (Nitrogen and Phosphorus Removal Case)

		
External Image of Unit	Example of Installation (1)	Example of Installation (2)

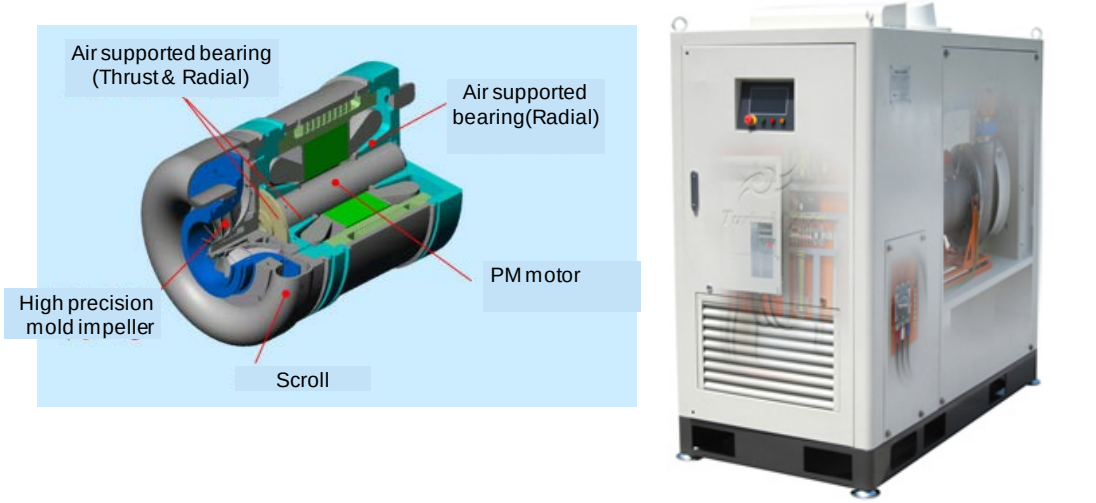
Source : Manufacturer's brochure

Photos: Image of Johkaso System

3.2 Other Equipment (Energy saving equipment)

(1) Energy Saving Type Blower

The power consumption of a blower used for a reactor is estimated to be about 20% of the total power consumption at a sewerage treatment plant. And an energy-saving blower has achieved about 10 to 15% energy savings by adopting an air supported bearing with no mechanical loss and a permanent magnet (PM) motor suitable for an inverter control.



< Appearance of blower package >

Source : Manufacturer's brochure

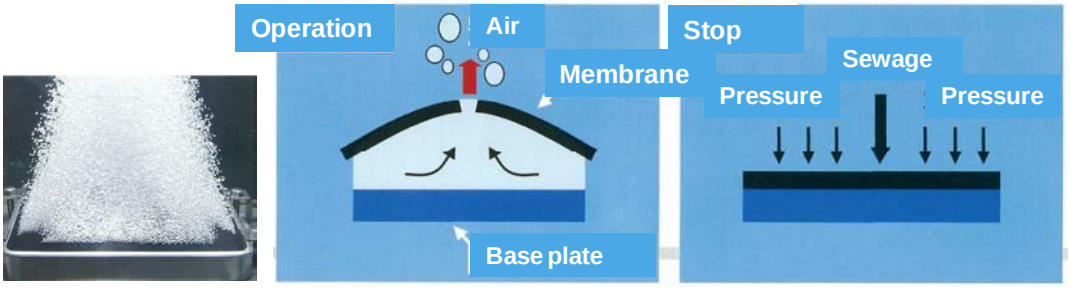
Figure 3.11 Energy-saving Blower

(2) Energy Saving Type Diffuser (Membrane type)

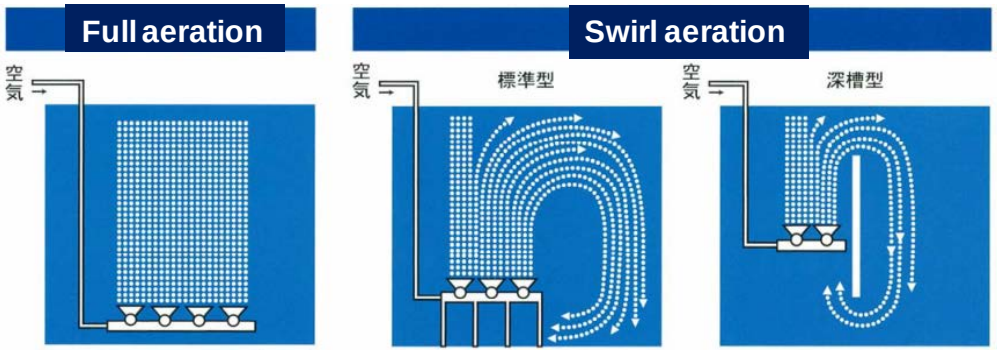
The diffuser which generates ultra-fine air bubbles using special membrane materials has higher oxygen transfer efficiency and less pressure loss compared to the conventional diffusers. Therefore it is effective for energy saving of a blower.

The power consumption of a blower is estimated to be about 20% lower by introducing an ultra-fine air bubble diffuser plate.

The diffuser can support full aeration as well as swirl aeration.



Ultra fine bubble **Less clogging mechanism**



Flow arrangement

Source : Manufacturer's brochure

Figure 3.12 Energy Saving Type Diffuser

(3) Energy Saving Type Diffuser (Aerator type)

This system crushes and refines air coming out from a blower with a mechanical aerator (aerator) to mix in the tank.

Since the power source is separated for a blower as an air supplier and an aerator, it is easy to follow the load fluctuation, making optimum operation possible to save power consumption.

Given that an aerator can be lifted up without dewatering the reactor and it is easy to replace with spare one at the time of maintenance, it can be said that the maintenance and management is also easy.

Source: Manufacturer's brochure

Figure 3.13 Energy Saving Type Diffuser (Aerator Type)

4. Sludge Treatment Facility (STF)

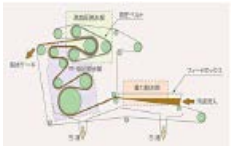
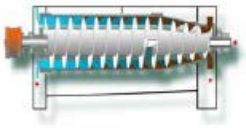
4.1 Dewatering/ Energy-saving Dehydrator

(1) Various Dewatering Equipment

Sludge treatment is one of the most significant processes in this project because sludge disposal is the critical point. The amount of water that is dewatered by a dehydration machine has a large effect on the following sludge treatment process such as drying.

There are 4 types of dewatering equipment; 1) screw press with multiple layered rings, 2) screw press, 3) belt press, and 4) centrifugal as shown in the following figure.

Table 4.1 Dewatering Equipment

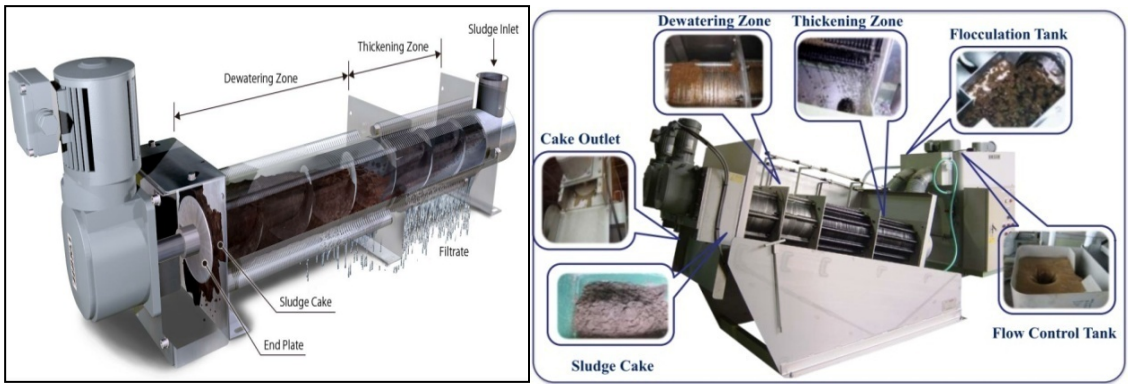
Category	Screw press with multiple layered rings	Screw press	Belt press	Centrifugal
Item				
Foot print	Small	Smallest	Largest	Large
Energy consumption	Smallest	Small	Small	Largest
Initial cost	Smallest	Small	Largest	Largest
O&M cost	Smallest	Small	Largest	Largest
Ease of O&M	Easy	Easy	Not easy	Not easy

Source: JICA Survey Team with manufacturers' figures

Out of four types of equipment above, 1) screw press with multiple layered rings, and 2) other types of screw press are introduced below as the most possible types for this project.

(2) Screw press with multiple layered rings

Sludge feed is regulated with the overflow pipe, returning excess volume to the sludge storage tank. Next, sludge is instantly thickened at the thickening zone, and dewatered at the dewatering zone in the subsequent stage under increasing inner pressure. Further pressure is applied from the outlet side with the end plate, discharging dewatered cake with 20±5%solides content.



Source: Manufacturer's presentation material

Figure 4.1 Energy-Saving Dehydrator (Screw Press with Multiple Layered Rings)

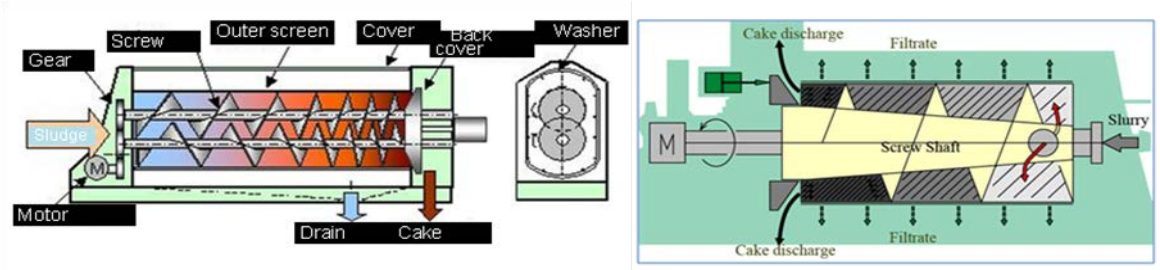
In summary Japanese screw press with multiple layered rings is compact, high performance and has the following characteristics;

- No clogging
- Easy maintenance
- Energy saving (low running cost)
- No thickened sludge storage tank required
- Continuous 24-hour unmanned operations
- Foul odor protection

It has already been installed 3200 units in 70 countries; which shows the excellence of the product.

(3) Energy saving type dehydrator (Other types)

There are the other screw press mechanisms as energy saving dehydrators, such as a double screw type and a pressing rotary outer cylinder type. The effect of energy saving and the feasibility of maintenance and management need to be compared and examined in feasibility study and detailed design stages for actual application in accordance with the detailed design criteria. As with the volute type dehydrator, the low LCC has been promoted based on sufficient materials as the basis.



< Double screw type > **< Pressing rotary outer cylinder-type screw press >**

Source : Manufacture's presentation material

Figure 4.2 Energy-saving Dehydrator (Other Type)

4.2 Mechanical Dryer

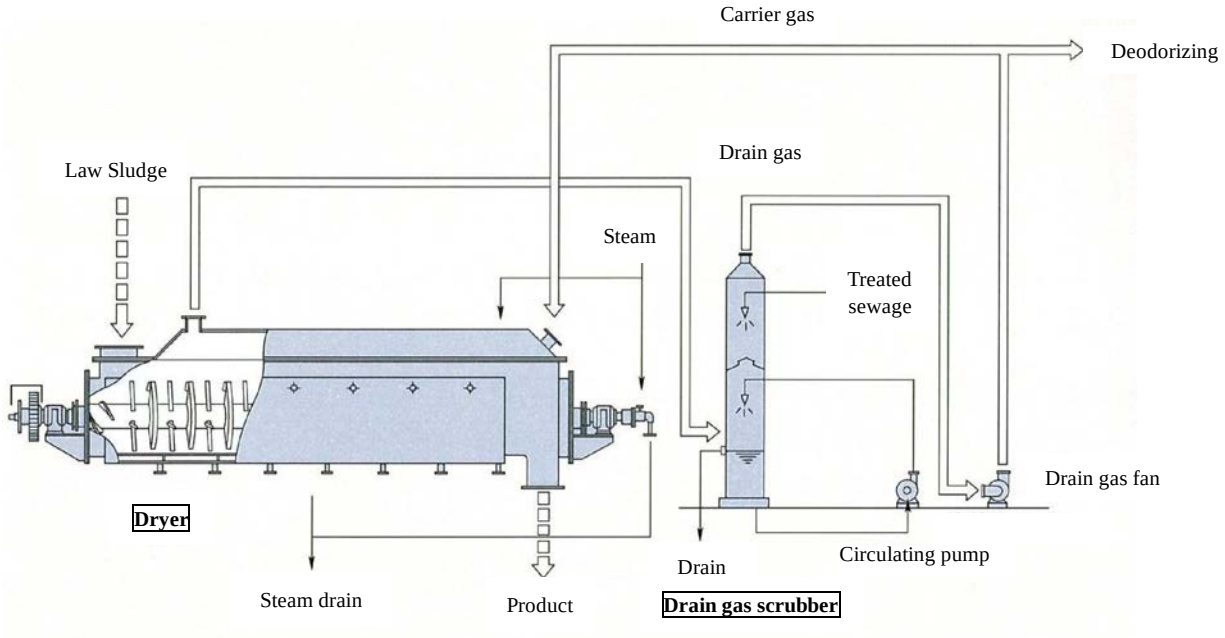
The mechanical dryer would be selected for drying process for the issues of sludge volume reduction and odour control. The overview of inclined disc dryer which would be suitable type for this project is described below.

Sludge is usually dried until the moisture content reaches about 70% in case an incinerator is installed on the following process. A large amount of energy as latent heat is required in the drying process regardless of drying method, which means energy saving technology is crucial.

Drying method can be divided into two types; direct heat dryer and indirect heat dryer. Inclined disc dryer is the latter and high heat transfer coefficient is materialized by its disc. Thermal efficiency is extremely high as heat losing area per effective heat transfer surface is small. These characteristics lead to save consumed energy. In addition, Japanese inclined disc dryer has self-cleaning system by the inclined disc for heat transfer surface, so heat transfer efficiency will be kept high, which makes energy-saving property even higher compared to other countries' products.

Also, a small amount of carrier gas is used and it emits only a small volume of exhaust gas.

Japanese inclined disc dryers have been installed in many countries, for example China, and they have been running very well. Lifetime could be 15 years in case proper O&M is conducted.



Source: Manufacturer's presentation material

Figure 4.3 Flow of Inclined Disc Dryer

5. Operation and Maintenance

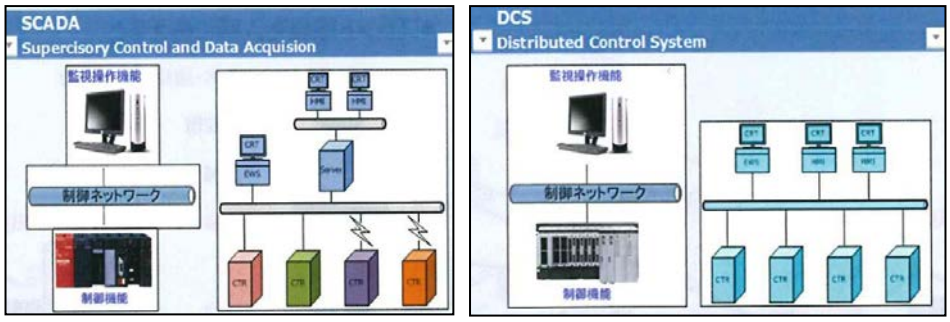
(1) SCADA System

For water supply system, Supervisory Control and Data Acquisition (SCADA) system, which makes it possible to centralize monitoring of all the facilities, has been introduced.

Even for the sewer system, a reliable SCADA system which is capable of centralized monitoring of the treatment plants and pumping stations which is likely to increase more in the future is needed and is expected to be introduced.

The SCADA system can be structured by combining generic products at low costs by a local company. However, as the scale of the system expands, it will be more difficult to keep the reliability level high.

On the other hand, Distributed Control System (DCS) which is one kind of SCADA systems uses a dedicated device with which high-speed data processing and a backup feature are available. So it is possible to secure high reliability at a large scale facility where a lot of devices are used in one plant. Therefore, it is common to use DCS at power plants and industrial plants where high reliability is mandatory.



Source : Manufacture's presentation material

Figure 5.1 Images of SCADA and DCS

(2) Pump Gate (full velocity and all water level type horizontal axis submersible pump)

The pump gate (horizontal axis submersible pump) is used for compulsive drainage from inland to the waterways with high water level in flooding events. Compared to the normal pumping station with gate, the pump gate has following advantage.

1) Utilization of existing waterways, 2) Small construction site, 3) Low construction cost, 4) Short construction period, 5) Low number of equipment, High maintainability

The applicable range is 0.1 to 3.0 m3/sec flow and 1.5-5.0m total head.

This technology was adopted in a drainage improvement project in Metro Manila ("Pasig-Marikina River Channel Improvement Project" by DPWH funded by JICA) in this year for the purpose of compulsive drainage to the river. Since Magsaysay Park as the candidate site for WWTP is beside Davao Gulf and there is some risk of flooding in extremely high tide cases, this technology can be utilized for urgent draining of treated water in flooding to protect the plant.

Source: Manufacture's brochure

Figure 5.2 Images of Pump Gate

APPENDIX 9.1_DRAFT SURVEY ITEMS IN PREPARATORY SURVEY (FEASIBILITY STUDY)

(1) General Engineering with Field Survey

1. Review of existing survey (=this data collection survey) and confirmation of latest sewerage development policy by Davao City
2. Re-determination of the target year, target area (Area A/Poblacion/Slum area) and target population
3. Review and re-determination of water consumption, wastewater generation
4. Review of effluent water quality standard and applied category for discharge point
5. Topographic survey in Magsaysay Park, Trunk Sewer Route, interception points from main drains
6. Geotechnical survey in same locations (assume 20 locations in total)
7. Flow and water level survey (2 to 3 times) in main drains incl. confirmation of existing survey and the reason
8. Water quality test in existing creeks, drains, and discharge from septic tank in Poblacion (and Agdao)
9. Collection of existing underground utilities information (planner, cross section, water supply, drains, communications, others)
10. Establishment of disposal site of biosolid from WWTP, study on legal framework for sludge disposal, discussions with concerned agencies
11. Review of existing road planning, flood control master plan, study on correlation with sewerage development

(2) Sewer Planning

1. Review of wastewater collection method in entire Davao City and target area of F/S in existing survey
2. Rough planning of lateral sewers in barangays and consider requirement/scale of lift pumping stations (manhole pumps) to connect to trunk sewers
3. Review of longitudinal profile of trunk sewer and preparation of rough structure of main pumping station. The P/S maybe changed to gate structure with pre-treatment facility such as screen unit and grit chamber.
4. Study on impacts to traffic and construction period by open cut method and trenchless method during construction, requirement of resettlements
5. Review of trenchless sewer installation sections with rough survey of traffic volume and road widths
6. Selection of type of pipe jacking method with consideration based on soil type and

groundwater level
7. Planning of locations of vertical shafts for trenchless sections
8. Consideration of interception structures from main drains and interceptor sewer dimensions
9. Consideration of flap gate installation location and method, rough structural consideration of interception chamber
10. Study on backwater to lateral drains from interceptors in heavy rainfalls
11. Determine the interception points from drains in slum areas
12. Study on impact of stormwater inflow by interception

(3) WWTP Planning
1. Review of WWTP location in existing survey
2. Review of wastewater quality (inflow) based on water quality test
3. Review of capacity calculations of tanks and equipment (wastewater flow and sludge flow) and preparation of wastewater and sludge treatment diagram
4. Consideration of deodorization facility
5. Study on needs for O&M equipment such as SCADA system, proposal of appropriate system (e.g. automatic operation, monitoring, alarm)
6. Planning of temporary work, piling work, earth retaining work based on soil data
7. Detailed planning of WWTP facilities incl. civil structures such as inlet pumping station, pre-treatment facility, equalization tank, and outlet pumping station, bypass channel, E&M equipment and land development based on topographic survey
8. Planning of numbers of equipment with operational plan including stand-by equipment.
9. Finalization of WWTP layout and structural drawings based on planning above
10. Planning of water park on the ground of plant

(4) Cost Estimate and Construction Plan
1. Review of preliminary cost estimate in this study
2. Detailed confirmation of unit prices (quotation from manufacturers with facility/equipment wise for WWTP and trenchless sewer installation, local prices for sewer installation)
3. Cost estimate (F/S level)
4. Study on LCC
5. Construction schedule
6. Study on safety control during construction
7. Procurement plan

(5) Implementation
1. Determination of the Implementation Framework and project management unit (Final discussion between Davao City and DCWD for construction and O&M)
2. Preparation of manning schedule of consulting service (incl. soft component)

3. Support for establishing implementation framework for sewerage development and septage management (particularly in case septage management program would be still pending in F/S stage)

(6) Economical and Financial Analysis
1. Review of financial scheme based on final cost estimate
2. Preparation of disbursement schedule
3. Study on appropriate sewerage tariff and collection
3. Calculation of FIRR and EIRR
4. Sensitivity analysis

(7) Environmental & Social Consideration
1. Final Environmental scoping in F/S stage
2. Support to proposed implementation agency of construction stage (City/DCWD) of the preparation of EIA
3. Public consultations (particularly on use of Magsaysay Park, sewerage fee, etc.)
4. Discussion on compensation (existing trees, workers in Magsaysay Park)
5. Assistance for preparation of simple resettlement plan by implementation agency

(8) Other
1. Gender and poverty awareness
2. Impact by climate change and the countermeasure (e.g. construction period)

APPENDIX 10_TECHNICAL SEMINAR REPORT

A technical seminar was held in Davao City for explanation of this report and introduction of Japanese sewerage technologies with inviting concerned agencies in Davao and various Japanese companies.

(1) Overview

1) Date: February 18, 2020 10:30-17:00

2) Program: (see the detail in Program attached)

10:30-12:00 Morning Session (Survey Result, Importance of Sewerage System)

13:00-17:00 Afternoon Session (Introduction of Japanese Sewerage Technologies), Fee Talk

3) Venue: Marco Polo Davao

4) Attendants: (see the detail in Attendants List attached)

Davao Side (54 persons):

Davao City, DCWD, DPWH Region XI, NEDA Region XI, DOH Davao, DBP Davao Rending Center, Barangays

Japan Side (19 persons):

JICA (head office, Philippine Office), Kitakyushu City, JICA Survey Team, Contractors

Total: 73 persons

(2) Pictures

The pictures of each session are shown in Table-1: Photos during Seminar.

(3) Major Questions and Comments

1) Survey Result by the Consultant

Q: How to handle the existing septic tanks without floors in which septage can infiltrate to the ground after sewerage development?
A: It is difficult problem depending on the area and condition. If it is in Area A and not congested area, the house toilet shall just connect to sewerage system and abandon the septic tank. But if it is congested area, the both of sewer connection and remodeling of septic tank are difficult. Depending on the condition, the house shall take either of sewer connection or remodeling of septic tank. In case of areas other than Area A, all the inappropriate septic tanks should be remodeled in accordance with city's septic tank rule as far as timing of sewerage development is not sure at present.

2) Importance of Sewerage System and Development History by Kitakyushu City

All the explanations were very clear and any query arised. (CPDO)

3) MBR Technology

Q1: How much is construction and O&M cost comparing with conventional activated sludge (CAS) process and how is frequency of membrane cleaning?
A1: Construction cost is not so big difference due to much decrease of space and civil work cost decreases. O&M cost is slightly more expensive than CAS and the difference get smaller and smaller due to improvement of membrane.
Q2: Can nitrogen and phosphorus be removed by membrane?
A2: Membrane itself cannot remove nitrogen and phosphorus. The additional tanks for nitrogen like the case of CAS and dosing of PAC for phosphorus are required.

4) Pipe-jacking Method

Q: How long is the maximum length of one span and how is the construction period?
A: Length and period of one span depend on soil and site conditions. At least more than 100m can be secured. Since we are supplier of pipe jacking machine, the construction companies know more about period.

5) Sewage Treatment Plant Constructions incl. Johkaso Unit

Q1: In case of MBR (flat sheet type), the disinfection is not required? Understanding is that fecal coliform can be removed with membrane.
A1: Yes, basically fecal coliform can be removed. But requirement of disinfection depends on effluent standard applied for the WWTP.
Q2: Can Johkaso unit treat the nitrogen and phosphorus?
A2: Yes, we have various type of Johkaso. The type which can treat nitrogen and phosphorus exist.

6) SCADA System

Q1: In case of applying for sewerage system, what kind of monitoring system can be established for area wide?
A1: In case flow monitoring points are setup, the flow can be monitored as the case of water distribution system.
Q2: Can SCADA System achieve fully automatic control of WWTP?
A2: Yes, it is possible.

Table A10.1 Photos of Technical Seminar in Davao (1)

	
Opening speech by Atty. Felizarta, Davao City (CEO)	Opening speech by Ms Otsuka, JICA Philippines
	
Explanation of survey results presented by Mr Hanabusa, JICA Survey Team	Q&A in survey result explanation
	
Importance of Sewerage System and Development History presented by Mr Matsumoto, Kitakyushu City	MBR Technology by Mitsubishi Chemical Aqua Solutions

Source: JICA Survey Team

Table A10.2 Photos of Technical Seminar in Davao (2)

	
Pipe Jacking Method presented by ISEKI Poly-Tech	Sewage Treatment Plant Constructions by Kubota
	
SCADA System presented by Yokogawa Philippines	Sludge treatment technologies explained by JICA Survey Team
	
Closing speech by Engr. Ivan Cortez, Davao City (CPDO)	Closing speech by Mr Ebisawa, JICA Philippines

Source: JICA Survey Team

Data Collection Survey for Sewerage System Development in Davao City

Seminar on Survey Results and Introduction of Applicable Japanese Sewerage Technologies for Davao City

Date: February 18 (Tue), 2020
Venue: Marco Polo Davao, BORMINSUL Banquet Hall

Program

10:30 – 12:00 : Morning Session

1. **Opening Speeches by Davao City (Atty. Joseph Dominic Felizarta, Head, CEO) and JICA Philippines (Ms. Momoko Otsuka, Representative) (10 minutes)**
2. **Presentation on the Survey Result by the Consultant (50 minutes incl. Q&A)**
   Including Introduction of Explainer Video on Survey Results and Proposed Sewerage Development, created by the Consultant (5 minutes)
3. **Presentation by Kitakyushu City (Importance of Sewerage System and Development History) (30 minutes incl. Q&A)**

12:00－13:00

4. **Lunch Break and Preparation for Afternoon Session**

13:00－17:00 : Afternoon Session

5. **Introduction of Japanese Sewerage Technologies Applicable For Davao City by Japanese Companies**

Moderator: Consultant (Nippon Koei Co., Ltd.)

13:00－13:05: Explanation of Program by the Consultant
13:05－13:25: 1. Presentation by Mitsubishi Chemical Aqua Solutions (MBR)
13:25－13:45: 2. Presentation by ISEKI Poly-Tech (Pipe-jacking Method)
13:45－14:05: 3. Presentation by Kubota (Sewage Treatment Plant Constructions)
14:05－14:25: 4. Presentation by Yokogawa Solution Service (SCADA System)
14:25－14:45: - Question and Answer -
14:45－15:10: - Coffee Break/Merienda -
15:10－15:40: 5. Introduction on Sludge Treatment Technologies etc. (Consultant)
15:40－15:45: Closing Speech by Davao City (Mr. Ivan Cortez, Head, CPDO)
15:45－15:50: Closing Speech by JICA Philippines (Mr. Yo Ebisawa, Senior Representative)

16:00－17:00: Free Talk between Philippine Side Attendants and Japanese Companies

SEMINAR ATTENDANCE SHEET

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
Technical Seminar on Introduction of Survey Results and Applicable Japanese Sewerage Technologies for Davao City
Marco Polo Davao
February 18, 2020 10:30-17:00

Sl No.	Country	Agency/Company	Region/Department	Name	Position/Department	Total per Agency
1	Philippines	Davao City Gov.	City Engineering Office (CEO)	**Atty. Joseph Dominic S. Felizarta, C.E., ENP**	Attorney IV/OIC-City Engr. & Bldg. Official	
2				**Engr. Allen A. Tibus**	Acting Asst. Division Head, Maintenance Division / Head of Drainage Management	
3				**Engr. Richard Elorde**	Project Engineer, Drainage Management	
4				**Engr. Estela Marie Labor**	Building Inspector	
5				**Bienna Mariz Rapal**	Secretariat	
6				**Chona Bedana**	Secretariat	
7				**Manuel Nobleza**	Admin Assistant	
8				**Engr. Michael Rebuta**	PDD, Mechanical Engineer	
9				**Engr. Arjean Jumamoy**	Head, Programming Division	9
10			CPDO	**Engr. Ivan C. Cortez**	Head, OIC, City Planning and Development Office (CPDO)	
11				**Engr. Samuel Alcordo Singco**	Engineer III City Planninng and Development Coordinator (/GIS Devision)	
12				**Lauis Panuncialman**	Economic Researcher, PPD-CPDO	
13				**Engr. Fevy Gebilaguin**	Plan and Programs Division	

SEMINAR ATTENDANCE SHEET

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Sl No.	Country	Agency/Company	Region/Department	Name	Position/Department	Total per Agency
14				**Jennylyn Saniel**	Plan and Programs Division	
15				**Lizbeth Singco**	Geographical Information System	
16				**Rona Marie Agulan**	Admin	
17				**Yolanda Ombing**	Zoning Division	
18				**Errol John Denosta**	Project Monitoring and Evaluation	9
19			City Economic Enterprise	**Ray JB N. Lingatong**	Admin Aide VI	
20				**Gerardo Antonio Castillo**	Acting Administrative Officer	2
21			City Architect	**Pedro Arthur Junsay**	Office of the City Architect	
22				**AR. Jessa E. Sumbrana**	Building Architect	2
23			City Environment and Natural Resources Office (CENRO)	**Engr. Marivic L. Reyes**	OIC	
24				**Engr. Fortune De Castro, Jr.**	Manager, Davao Sanitary Landfill, CENRO	
25				**Engr. Lakandiwa Orcullo**	CENRO-Environment Waste Management Division	
26				**Engr. Felinee D. Cabrera**	CENRO-Environment Waste Management Division	4
27			City Budget Office	**Ms Veronica Lassie B. Del Mundo**	Administrative Officer IV, City Budget Office (Financial)	

SEMINAR ATTENDANCE SHEET

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28				**Ms Myla Divina Angeles**	Audit Analyst	2
29			City Health Office (CHO)	**Mr Curtis Lazarraga**	Chief Sanitary Inspector	1
30			Park Economic Enterprise Office	**Josephine F. Aquino**	OIC	
31				**Josephine Briones**	Clerk II	2
32			Davao City Chamber of Commerce and Industry	**Ms Marc Faith Wales**	Executive Director	
33				**Yvonne Cabada**	Board of Trustee	
34				**Kathleen Dalig**	Trade and Commerce Lead	3
35		DCWD		**Dir. Romel Alfredo R. Ruiz**	Board of Director	
36				**Engr. Christine S. Guarde**	OIC, Planning Unit Engineering and Construction	
37				**Ms Jade C. Veloso**	Planning and Monitoring Division, Sr. Corplanning Analyst	
38				**Ms Anji Laura Grecia-Lorona**	OIC, Watershed Management Division	4
39		DPWH	Region XI	**Engr. Vanine Mae Diente**	Engineer II, DPWH-DCDEO Planning and Design Section	
40				**Engr. Nowell Penonia**	Engr III, PDD	2
41		NEDA	Region XI	**Francesca Dianne B. Solis**	EDS 2	1

SEMINAR ATTENDANCE SHEET

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February 18, 2020 10:30-17:00

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42		DOH	Davao	**Engr. Felvie Omnos**	Licensing Officer 3	1
43		Barangays	Davao	**Jose D. Tamayo Jr.**	Barangay Captain, Agdao Proper	
44				**Pedro Arthur Junsay**	Barangay Secretary, Agdao Proper	
45				**Gregorio L. Obial, Jr.**	Barangay Captain, Wilfredo Aquino	
46				**Melrose Bacasimas**	Barangay Secretary, Wilfredo Aquino	
47				**Robert M. Diaz**	Barangay Captain, Tomas Monteverde	
48				**Leomar Sacon**	Barangay Kagawad, Tomas Monteverde	
49				**Prescilla C. Loredo**	Barangay Treasurer, Tomas Monteverde	
50				**Robert Mendoza**	Barangay Kagawad, 27-C Poblacion	
51				**Evan Andrade**	Barangay Staff	
52				**Lita Empis**	Barangay Captain, Leon Garcia	
53				**Joel Crisanto**	Barangay Kagawad, Leon Garcia	11
54		DBP	Davao Lending Center	**Ms Faye Carmina T. Pimentel-Rodriquez**	Account Officer, Davao del Sur Lending Center	1
					Philippine Side	**54**

SEMINAR ATTENDANCE SHEET

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
Technical Seminar on Introduction of Survey Results and Applicable Japanese Sewerage Technologies for Davao City
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February 18, 2020 10:30-17:00

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55	Japan	JICA	Head Office	**Mr Hideo Sugiyama**	Southeast Asia Division 5 (Philippines), Southeast Asia and Pacific Department	
56			Philippines	**Mr Yo Ebisawa**	Senior Representative	
57				**Ms Momoko Otsuka**	Representative, Environment and Social Development Section, Program Group2	3
58		JICA Survey Team	Tokyo	**Mr Masahide Hanabusa**	Team Leader	
59		(Nippon Koei)		**Mr Yoshitomo Miura**	WWTP Expert/Manager	
60			Davao	**Ms Candy V. Abique**	Assistant	
61				**Ms Karen Miranda**	Assistant	4
62		Kitakyushu City	Water and Sewer Bureau	**Mr Minoru Matsumoto**	Manager, International Project Div., International Project Dept.	
63				**Mr Tooru Tarumi**	International Project Div., International Project Dept.	2
64	Company	Kubota	From Tokyo (MBR/STP)	**Mr Hideki Kawamura**	Senior Manager, International Environmental Engineering Dept.	
65				**Mr Hiroomi Yoshikawa**	Manager, International Environmental Engineering Dept.	2
66		Mitsubishi Chemical	From Tokyo (MBR)	**Mr Kyohei Ozaki**	Sales & Marketing Manager, Membrane Dept.	1
67		Iseki Polytec	Indonesia Representative Office	**Mr Alvan Sukmawijaya**	Manager	1

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68		JFE	From Manila (STP)	**Mr Shinji Okayama**	JFE Philippines Representative	1
69		Yokogawa Electric	From Manila (SCADA)	**Mr Michinao Takamuku**	Deputy Managing Director, Yokogawa Philippines	
70				**Mr Buddy S. Bocarile**	General Manager - Project, Yokogawa Philippines	
71			Davao	**Ms Krissa Talado**	Assistant Sales Engineer, Product Sales Dept.	3
72		Hitachi	From Tokyo (STP/SCADA)	**Mr Kazuo Nakano**	Deputy General Manager	1
73		Toshiba	From Tokyo (STP)	**Mr Kazuki Akashi**	Sales Manager	1
					Japanese Companies	10
					Japan Side	**19**
					Grand Total	**73**